Aviation Week & Space Technology

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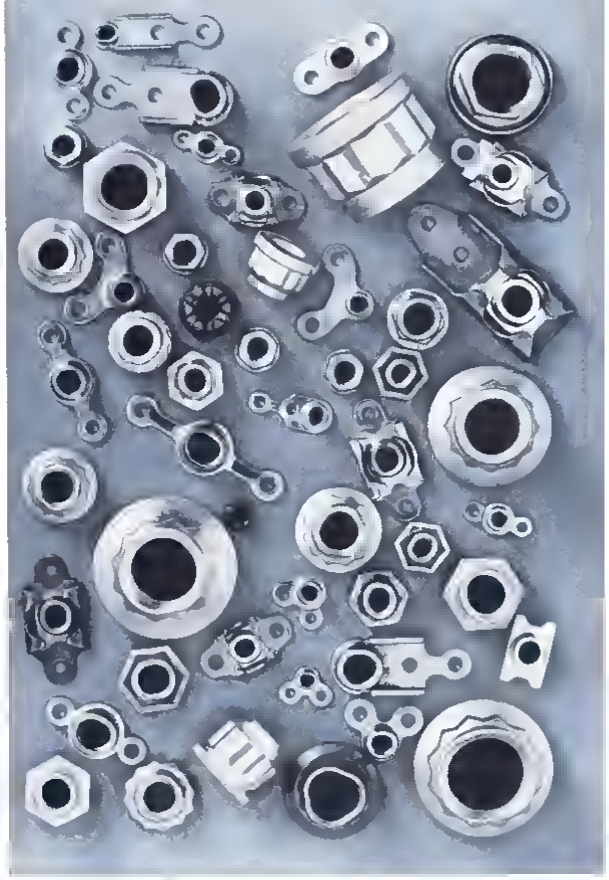
May 6, 1963

SPECIAL REPORT:

Mariner C Mars-Flyby Spacecraft

Piper Twin Comanche Formation



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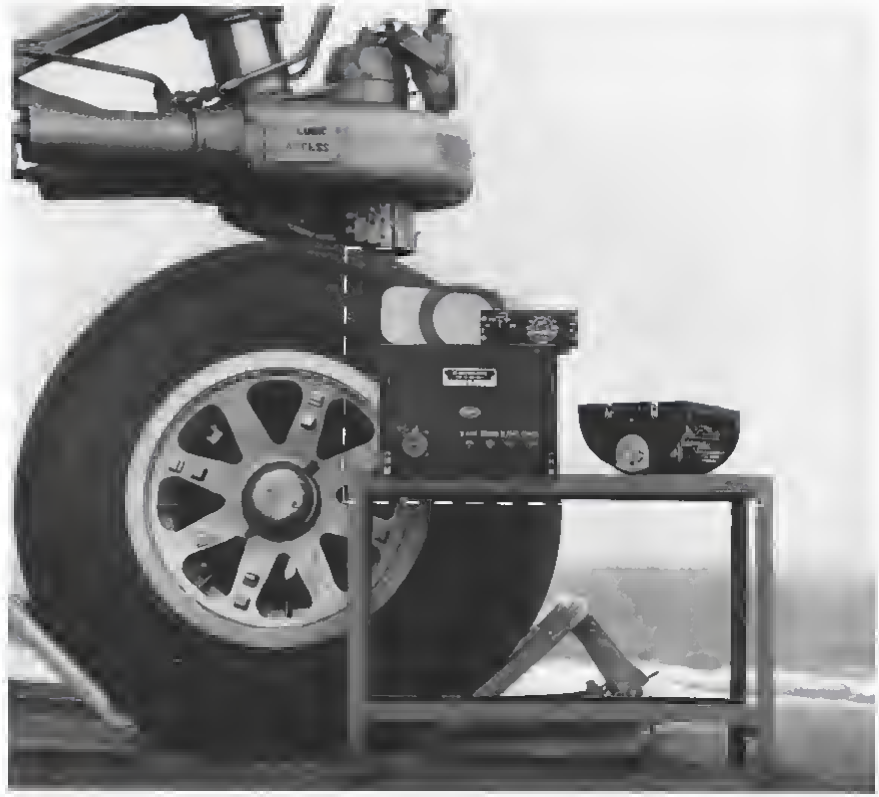

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AEROSPACE CALENDAR

May 13-15—Conference on Single-Crystal Films, Philco Scientific Laboratory, Blue Bell, Pa. Co-sponsors: University of Pennsylvania, Princeton University, Office of Naval Research, Advanced Research Projects Agency.

May 13-15—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio.

May 14—Space Simulation Vacuum Temperature Radiation Symposium, American Nuclear Society, Sheraton-Atlantic Hotel, New York, N. Y.

May 15-16—Fourth Annual Symposium on High Speed Testing, Hotel Somerset, Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 16—Second Annual Management Conference on Marketing in the Defense Industry, American Marketing Assn., Boston College Campus, Boston, Mass.

May 20-22—17th Annual Convention and Exhibit, American Society for Quality Control, Sherman House, Chicago, Ill.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.

May 20-23—Design Engineering Conference,

(Continued on page 7)

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May 6, 1963

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AEROSPACE CALENDAR

(Continued from page 5)

American Society of Mechanical Engineers, Americana Hotel, New York, N. Y.

May 20-24—Reliability and Maintainability Training Courses, Arnac Research Corp., Hotel Willard, Washington, D. C.

May 20-24—Third European Spaceflight Symposium, Stuttgart, West Germany. Sponsors: British Interplanetary Society (BIS), Societe Francaise d'Astronautique (SFA), Deutsche Gesellschaft fur Raketentechnik und Raumfahrt e. V. (DGRR).

May 21-22—1963 Seminar-Exhibit, Standards Engineers Society, Carnegie International Endowment Center, New York, N. Y.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 21-23—Symposium: Characteristics of the Lunar Surface, Boston, Mass. Sponsors: Air Force Cambridge Research Laboratories, Arthur D. Little, Inc.

May 21-24—25th Annual Meeting and News Conference, Aviation/Space Writers Assn., Adolphus Hotel, Dallas, Tex.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

May 27-28—23rd National Meeting, Operations Research Society of America, Sheraton Hotel, Cleveland, Ohio.

May 27-29—17th Annual Frequency Control Symposium, Shelburne Hotel, Atlantic City, N. J. Sponsor: U. S. Army Electronics Research & Development Laboratory.

June 2-14—Third Annual Reliability Institute, University of Connecticut, Storrs, Conn.

June 3-5—Symposium on Materials and Processes for Space Power and Primary Propulsion, Society of Aerospace Material and Process Engineers, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

June 4-6—17th Annual Convention and Exhibition, Armed Forces Communications & Electronics Assn., Sheraton Park Hotel, Washington, D. C.

June 4-6—Ninth Annual Radar Symposium (Secret), conducted by the University of Michigan at Fort Monmouth, N. J. Sponsors: USA, USN, USAF.

June 4-6—National Electronic Packaging and Production Conference, Coliseum, New York, N. Y.

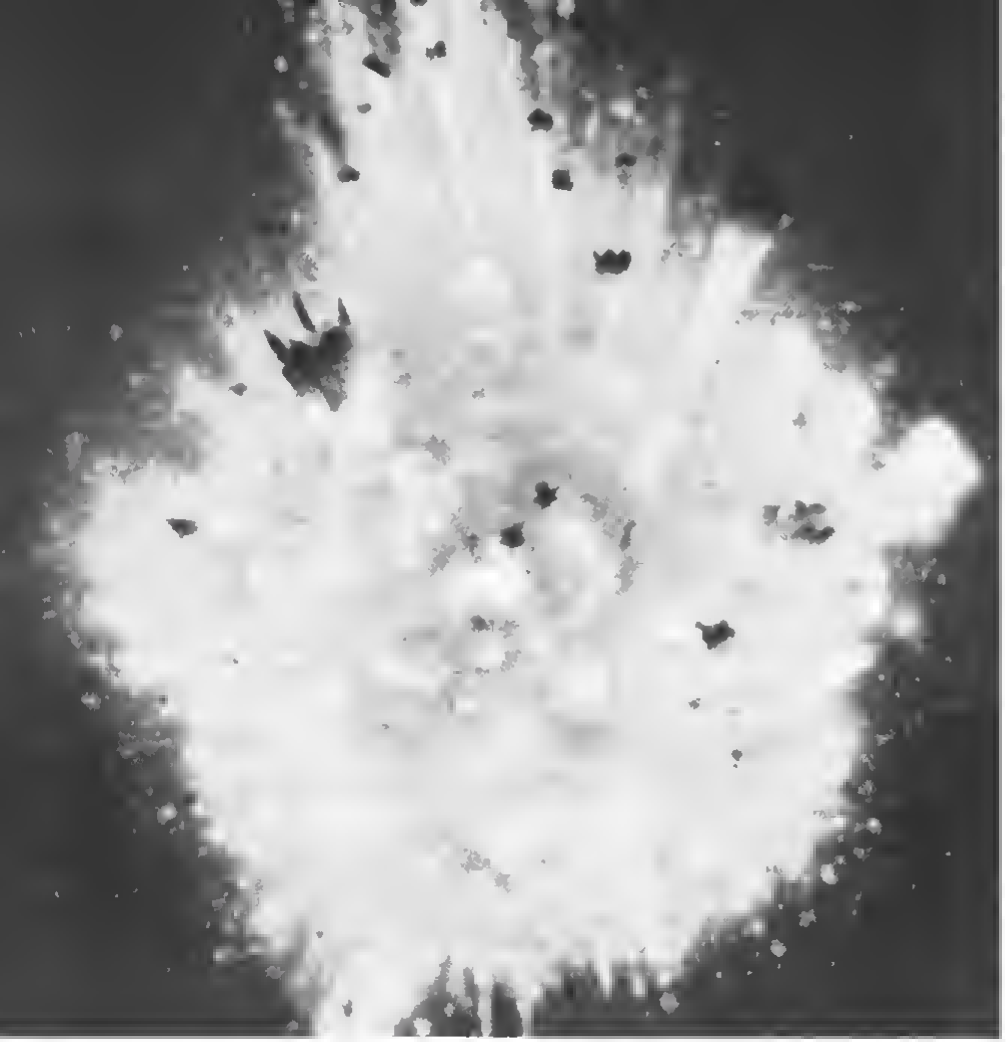
June 6-7—Symposium on the Exploration of Mars, Denver Hilton Hotel, Denver, Colo. Sponsor: American Astronautical Society. Co-sponsors: American Astronomical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections, NASA.

June 7-8—14th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

June 11-14—Symposium on Plasma Space Science, The Catholic University of America, Washington, D. C., with the

(Continued on page 9)



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AEROSPACE CALENDAR

(Continued from page 7)

support of NASA and Goddard Space Flight Center

June 12-14—Heat Transfer and Fluid Mechanics Institute, American Institute of Aeronautics and Astronautics, California Institute of Technology, Pasadena

June 13-15—Great Lakes Navy Research and Development Clinic, Ohio State University, Columbus, Ohio, conducted by the Office of Naval Material

June 17-20—Summer Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles

June 17-21—Summer General Meeting, Institute of Electrical and Electronics Engineers, Toronto, Canada

June 18-20—41st Meeting, Aviation Distributors and Manufacturers Assn., Chateau Frontenac, Quebec, Canada

June 19-21—Fourth Joint Automatic Control Conference, University of Minnesota, Minneapolis, Minn. Sponsors: American Institute of Chemical Engineers, Institute of Electrical and Electronic Engineers, American Society of Mechanical Engineers, Instrument Society of America

June 26-27—10th Annual Symposium on Computers and Data Processing, University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo.

June 26-27—Symposium on Dynamic Load Problems—Helicopters and V/STOL, Statler Hilton Hotel, Buffalo, N. Y. Sponsors: Cornell Aeronautical Laboratory, Army Transportation Corp.

June 28-July 3—Second Annual Dorado Fly In, Dorado Beach Hotel, Dorado, Puerto Rico

July 7-11—Seventh National Conference on Aerospace Education, National Aerospace Education Council, Hotel Deauville, Miami Beach, Fla.

July 9-11—International Symposium on Space Telecommunications, Institute of Electrical and Electronic Engineers' Professional Group on Antennas and Propagation, Boulder Laboratories, Boulder, Colo.

July 10-12—Meteorological Support for Aerospace Testing and Operation, American Institute of Aeronautics and Astronautics and American Meteorological Society, Fort Collins, Colo.

July 23-26—Torpedo Propulsion Conference (Confidential), American Institute of Aeronautics and Astronautics, U. S. Naval Underwater Ordnance Laboratory, Newport, R. I.

Aug. 4-9—International Conference and Exhibit on Aerospace Support, Institute of Electrical and Electronics Engineers/American Society of Mechanical Engineers, Park Sheraton Hotel, Washington, D. C.

Aug. 12-14—Guidance and Control Conference, American Institute of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, Mass.

Aug. 19-21—Astrodynamics Conference, American Institute of Aeronautics and Astronautics, Yale University, New Haven, Conn.

Aug. 20-23—1963 Western Electronic Show and Convention (WESCON), Cow Palace, San Francisco, Calif.

Sept. 22-27—14th International Astronautical Federation, Paris, France.

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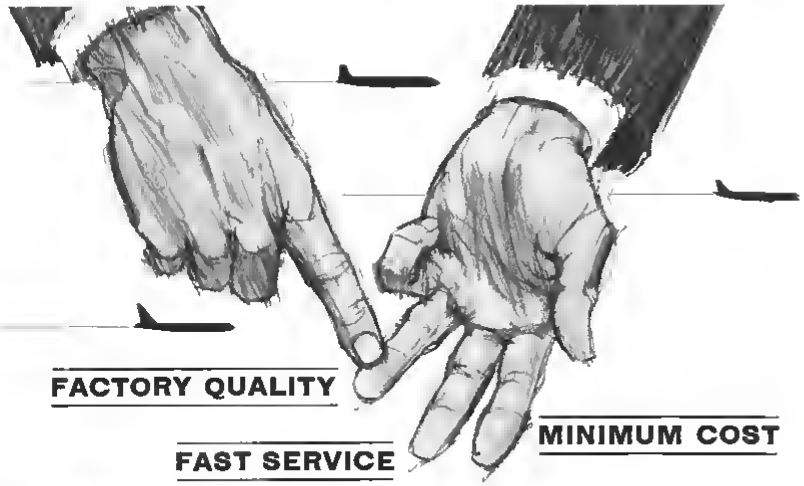

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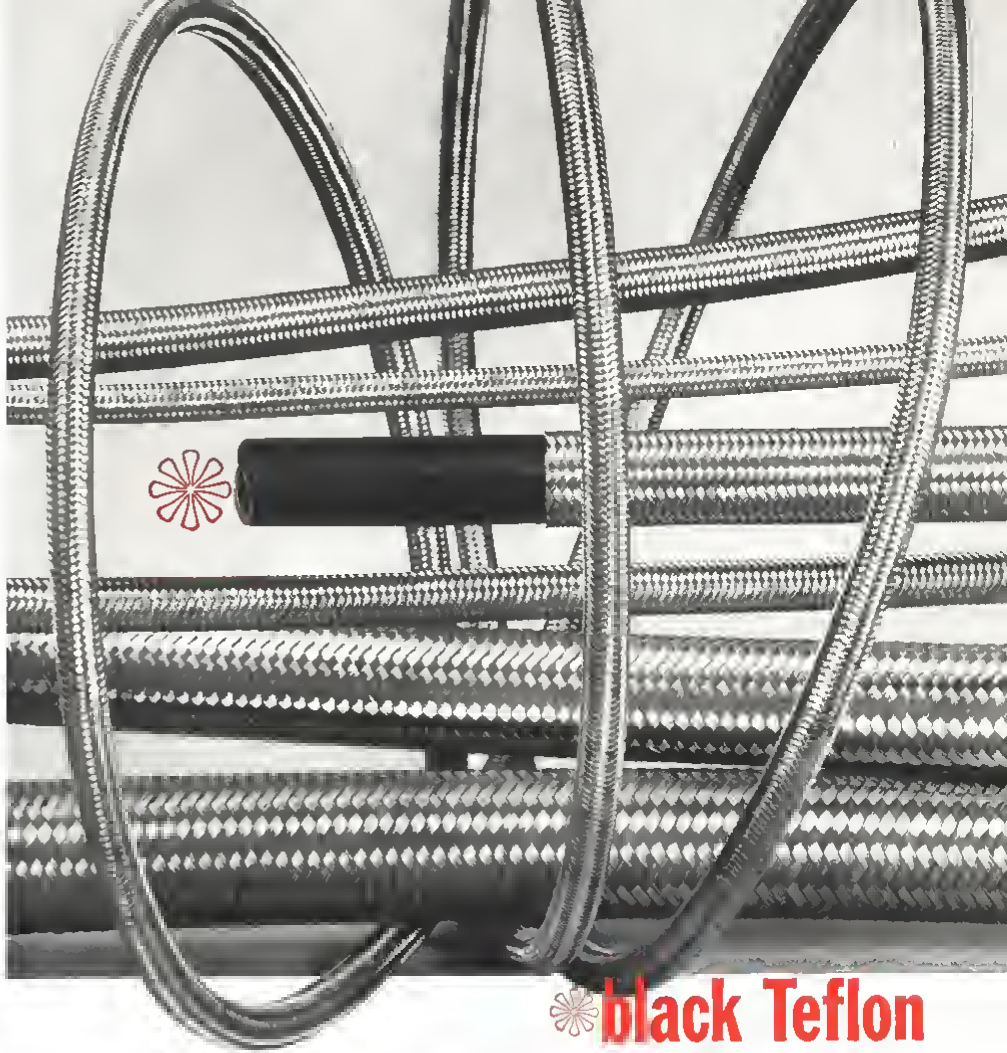

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May 6, 1963

CONTENTS

COVER Newest twin engine aircraft in the Piper line is the PA-30 Twin Comanche, adapted from the manufacturer's former single engine aircraft Twin Comanche is powered by two Lycoming IO-320-B fuel injection engines Gross weight has been increased to 3,600 lb and top speed is 205 mph Aircraft has glass-fiber nose and nacelle air intake sections For further details on design and engineering of the aircraft, SEE p 106

PICTURE CREDITS

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EDITORIAL

Forecasting the Wild Blue Yonder

In the sprawling Arbor Vitae complex not far from Los Angeles International Airport, the best brains of the Air Force are now engaged in an extremely significant effort to forecast the technical and military future of this service (AW Apr. 8, p. 25). It is certainly an appropriate time for this exercise, as this service is beset by grave problems arising from shifting military and political requirements and the galloping technology of the postwar era that shows no indication of abating its fierce pace. In addition to the implosive force of these external problems, the Air Force is also facing an internal crisis of leadership, generated by the passing of time and the changing character of its mission.

From its beginning with the Wright biplanes at Ft. Myer, Va., just across the Potomac from Washington, the military air service has always faced the problem of maintaining its position astride a technical revolution. For several decades this technology pursued a relatively uncomplicated course aimed at developing winged vehicles that could fly farther, faster and carry heavier lethal loads—although it was marked by major changes in direction, such as the switch to all metal construction, application of electronics, the gas turbine engine, supersonics, nuclear armament and many others.

But during the past few years this simple line of development has expanded into a technical spectrum of enormous scope, from vertical-takeoff-and-landing machines to space vehicles, and its area of military operations now stretches from jungle guerrilla warfare to cislunar space. And at both ends of this spectrum it finds other government organizations chipping at its technology and missions. The Air Force is faced today with a technical and military complexity that dwarfs anything in its previous experience or indeed in the experience of any other military organization in history. It is feeling the strain of revolutionary technology on evolutionary organizational structures and the flood of changing political tides over traditional doctrine.

A Service Divided

It was perhaps inevitable that during this period of multiple change the Air Force tended toward overfactionalism, giving rise to the Pentagon jest, "Which Air Force are you talking about?" Strategic Air Command had its overriding priority mission and pursued it with admirable technical and organizational vigor, though without much regard for the other elements of the service. Tactical Air Command and Air Defense Command went their separate ways with shrinking budgets, aging equipment and diminishing interest from top USAF and Defense Dept. leadership. The undeniable importance of expanding the technical scope developed strong new competitors for resources, promotion and policy voice in the Air Research and Development Command and its even more powerful successor, the Systems Command.

If the less glamorous areas of its technical and military field, such as tactical air support, were neglected in this era, so also were some of the most glamorous areas such as space, painted in unrealistically rosy hues. During much of this period, the fact that the Air Force was getting by far the largest slice of the military budget pie made its top leadership reluctant to respond to alarms raised over future problems. Over-complacency on its favored budget role resulted in neglect of sound future planning at the top, despite some anguished concern over this growing gap at lower levels.

The National Aeronautics and Space Administration sprang into being and quickly took the major role in space exploration from the military sphere. Although it had been far ahead of its civilian leaders in anticipating the requirements of space technology, and was working hard in this area in the pre-Sputnik era, the Air Force was quickly forgotten in the post-Sputnik panic, under the ominous doctrine that the peaceful uses of space excluded any efforts at self-defense. In an understandably exaggerated reaction, the Air Force developed some pretty flimsy operational plans for its desired space role that almost envisioned throttle jockeys dueling the enemy in space in the same manner that Sabres and MiGs tangled over Korea.

Shrinking Horizons

At the other end of the technical range, the Army expanded its own aviation as much as possible and nibbled hard at USAF roles that it felt, with some validity, were being neglected. In the middle, the Navy Polaris carrying submarines sailed into SAC's hitherto sacrosanct role as the strategic deterrent, and USAF saw its budget edge over the other services reduced considerably.

Not since the end of World War 2 has the Air Force taken such a comprehensive view of its future prospects in the technical spectrum. At that time, far-sighted Gen. Henry H. Arnold drafted Dr. Theodore von Karman to head a team that charted the technical trends of the first postwar decade in the now famous report "Toward New Horizons." The von Karman forecast of the technical future proved to be remarkably accurate and served USAF well in keeping astride the explosive technology of supersonics, rocket propulsion and thermonuclear armament.

Hopefully, Project Forecast will develop the same type of thorough and technically accurate chart for USAF in the next decade. It is a job that must be done.

—Robert Hotz

WHO'S WHERE

In the Front Office

Dr. John J. Myers, vice president, Surface Based Electronic Systems, North American Aviation's Columbus (Ohio) Div., and Dr. James F. Reagan, vice president, Missiles.

Dr. John M. Teem, a corporate vice president, Electro-Optical Systems, Inc., Pasadena, Calif.; he continues as technical director. Also, Leslie J. Cook, a vice president; he continues as manager, Electric Propulsion Flight Test Program.

Robert E. Chasen, executive vice president, ITT Kellogg Communications Systems, Chicago, Ill., a division of International Telephone and Telegraph Corp. Also, Robert A. Marshall, vice president-marketing, ITT Federal Laboratories, Nutley, N. J., a division of International Telephone and Telegraph Corp.

V. C. Weddle, vice president and general manager, Cessna Aircraft Co.'s Commercial Aircraft Div., and Frank Martin, vice president-marketing, commercial aircraft.

John L. Mead, vice president-industrial relations, Aerojet-General Corp., El Monte, Calif.

Guy B. Entrekin, Jr., a vice president, Bourns, Inc., Riverside, Calif.; he also is general manager of Instrument Div.

Alexander D. Bruce, board chairman and chief executive officer, Vapor Corp., Chicago, Ill., and Laurence H. Gillick, vice chairman. Arthur J. Loose succeeds Mr. Bruce as president.

Lester L. Kilpatrick, board chairman, California Computer Products, Inc., Anaheim, Calif., his successor as president has not been named. Dr. Donald W. Gade, senior vice president, is acting chief executive officer.

Dr. John V. Harrington has been appointed director of Massachusetts Institute of Technology's new Center for Space Research, Cambridge, Mass. He was also appointed Professor in the Departments of Electrical Engineering and Aeronautics and Astronautics. Lawrence E. Beckley is administrative officer for the center.

Brig. Gen. William W. Veal, commander of the Defense Electronics Supply Center, will become Auditor General, Air Force Comptroller's Office, Air Force headquarters, Washington, D. C., in September.

Honors and Elections

Dr. Bernhard H. Goethert, director of engineering for ARO, Inc., has been appointed interim chairman of the Inter-Panel Space Information Group of AGARD (Advisory Group for Aeronautical Research and Development).

Stanley Hiller, Jr., president of Hiller Aircraft Co., has been elected president of the American Helicopter Society, succeeding Edwin J. Ducayet, president of Bell Helicopter Co., now board chairman of the Society. Norman C. Taylor, assistant director-engineering for Boeing's Vertol Div., was elected secretary-treasurer.

Maj. Robert M. White has received a Distinguished Service Medal from the Air Force for his research flights in the North American X-15.

(Continued on page 118)

INDUSTRY OBSERVER

► Navy is experiencing so many problems with its Talos, Terrier and Tartar shipboard anti-aircraft missile systems that it has contracted with Control Data Corp., Radio Corp. of America and Raytheon to analyze the difficulties and recommend a remedial program. Each company is to analyze one missile system. Interim report indicates that it may cost $250 million to correct subsystem incompatibilities on only one of the missile systems.

► **Army has asked for technical data from industry on concepts for a heavy-lift helicopter rotor system employing one or more jet engines on each rotor. Data should lead to fabrication, ground and flight test of a research aircraft.**

► Launch of the polar ionospheric beacon satellite, designated S-66, at Pacific Missile Range has been postponed by NASA from May 7 while the agency studies desirability of a ground test of the Scout first-stage Aerojet Algol motor. Checkout indicated it had a hang-fire potential.

► **Fueling systems at several USAF bases will be investigated by Aeronautical Systems Div. to determine the level of microbiological and related contaminants. Industry bids will be submitted by May 20. Bases to be studied include Davis-Monthan, Ariz.; Beale, Calif.; Fairchild, Wash.; Blytheville, Ark.; Shaw, S. C., Eglin, Fla., Wurtsmith, Mich., and Loring, Me.**

► Air Force has scheduled 20 air-drop flights and 10 Titan 3 launches in the X-20 (Dyna-Soar) development program. Four of the drop flights will be powered to provide dynamic pressure information up to Mach 15.

► **Industry approaches for design and development of methods of non-hazardous thrust termination of solid-propellant motor systems are being analyzed by Rocket Research Laboratory, Edwards AFB, Calif. Aim is to achieve methods of thrust termination during early phases of lift-off, for precise control of impulse, and during staging of large boosters.**

► First flight of FLIP (Flight-launched infrared probe) pod was to have been aboard the second Atlas advanced ballistic re-entry system (Abres) vehicle, launched from Cape Canaveral Apr. 26, but technical difficulties forced its removal. FLIP, built by General Dynamics/Astronautics, is 82.15-in.-long, 29.5-in.-wide, two-segment pod attached to the side of the Atlas. Packages are fired from the Atlas at an angle during boost phase to gather data on the infrared characteristics of the vehicle in flight.

► **Industry plans for large solid-propellant motors as liftoff assist devices, boosters and building blocks for space vehicles will be evaluated by NASA's Manned Space Center. Boost-assist will be related to Advanced Nova, sea launch and 50-100 ton recoverable, single-stage to orbit and nuclear-powered vehicles. Proposals for the task will be submitted by May 13.**

► USAF's Aeronautical System Div. plans a program aimed at developing techniques which will enable a reconnaissance aircraft to correlate instantly information obtained from side-looking radar, infrared mapping, aerial cameras and terrain mapping. Techniques may be intended for use on the F-111 (TFX) or the RS-70.

► **Electro-thermal research and development program proposed by industry to NASA's Lewis Research Center will be concerned with thruster system operating at a power level between 2 and 3 kw., with specific impulse between 800 and 900 sec. and efficiency of .60 to .70. Test runs must extend under essentially steady-state conditions for a minimum of 10 min.**

► USAF's Space Systems Div. is evaluating proposals for development of guidance laws for maneuvering in space, where intercept and target vehicles would be in earth orbits with perigees exceeding 75 naut. mi. and apogees not exceeding 300,000 naut. mi. Angle between the two orbital planes could range from 0 to 90 deg. Interceptor would be powered with a non-throttleable, restartable engine. Target vehicle would be non-maneuverable. Airborne computing equipment for the guidance system would have to be available in the 1967-70 period.

Washington Roundup

Anti-Missile Progress

Progress on anti-missile missile development is being reviewed "once every 90 days" by Defense Secretary Robert McNamara, he told the Senate Defense Appropriations Subcommittee recently. McNamara said he meets with Army Chief of Staff Gen. Earle G. Wheeler, Army research and development chief Lt. Gen. Dwight E. Beach, and project leaders from Bell Laboratories and Western Electric. He said Bell Labs has done "a perfectly magnificent job of development management for us on what is an extraordinarily difficult problem," and said he has been assured that the U.S. is spending as much as it profitably can on the anti-missile right now.

Air Force, largely through its Scientific Advisory Board, will soon begin analyzing what percentage of its budget is devoted to research to determine whether it is adequate. Chief of Staff Gen. Curtis E. LeMay, who suspects the percentage is too small, said this will be a high priority project in Fiscal 1964.

Situation Normal, Etc.

Soviet space launchings and U.S. military space shots will again be listed in National Aeronautics and Space Administration's Satellite Situation Report, beginning next week. Since last summer, when Defense Dept. quit providing information to NASA on its shots and Russian shots, the report has listed only civilian launches. Meanwhile, U.S. reports to the United Nations have been including all U.S. flights. They also have blanks in the numbering system, making it obvious that the omissions represent Soviet shots. To put some consistency into the inconsistency, NASA's report will skip numbers when a Russian shot is made but not announced. If the shot is announced by Russia, it will appear in the report with the name Russia gives to it.

Defense Dept. is discovering that the 12-to-14-hr. daily work schedules of its top officials are so inelastic that "fire drills" such as the TFX investigation (see p. 24) or the recent Cuban crisis bring many routine activities to a halt. Most seriously affected by the current effort to justify the TFX decision is the office of the director of defense research and engineering, where a number of projects are stalled—requiring the military services in turn to slow down their work. Although the Pentagon claims that the TFX "Blue Team" (AW Apr. 29, p. 23) numbers only a dozen or so, unofficial estimates are that it numbers more than 200 when those in the field at such places as the project office at Wright-Patterson AFB are included.

Complex Operations

NASA's Launch Operations Center at Cape Canaveral is proposing that the operation of its 70,000-acre Merritt Island complex be split among several contractors, with NASA in over-all charge. Air Force uses only one prime contractor, Pan American's Guided Missile Range Division, to operate the Atlantic Missile Range, and Pan American picks its own subcontractors.

General Electric Co. recently received a housekeeping contract for NASA's Mississippi Test Facility as an extension of its Apollo integration and checkout contract, and there was speculation here last week that this might be extended to cover the Merritt Island job. GE bid for the Atlantic Missile Range job two years ago when the Pan American contract was up for renewal.

The LOC proposal has not been forwarded to headquarters for approval and it may be several months before the housekeeping situation is settled. First support contract for Merritt Island, covering communications services and land lines, will be awarded in a few weeks.

An Aerobee sounding rocket was fired vertically on Apr. 18 as Explorer 17 was orbiting overhead at a 160-mi. altitude in a NASA attempt to get simultaneous vertical and horizontal measurements of atmospheric neutral gas. A built-in offset assured that the rocket would miss the satellite. Miss distance was 35,000 yards.

The Scabbard Gap

Breadth of the spectrum of modern weapons now being procured by Defense Dept. and the complexity of developing them was illustrated by two items on the same page of a recent issue of Commerce Dept.'s Business Daily.

One calls for design and development of missile launch crew procedures trainers for the Atlas intercontinental missile. The other announces a one-year Army Quartermaster Research and Engineering Command study for development and design of "a new and improved sheath for machete." For the machete work military specifications must be followed and bi-monthly and monthly reports are required. Bidders must furnish an estimate; a detailed plan of approach, a list of project personnel, including their backgrounds and experience "in similar or allied fields of endeavor;" and a list of "equipment on hand or requiring purchase."

It is not known yet whether Army intends to award a weapon system integration contract for getting the machetes into the sheaths.

—Washington Staff

Gemini Manned Flight Now Year Late

Cost now estimated at about $1 billion; schedule reoriented to include one more unmanned mission.

By Alfred P. Ahbrando

Washington—First Gemini manned flight has shipped a total of one year to late 1964 and the cost of the program now is expected to go over $1 billion—twice the original estimate.

Brainerd Holmes, director of manned space flight for the National Aeronautics and Space Administration, told the House subcommittee on manned flight that delays in development of several Gemini spacecraft systems and technical problems in man-rating the Titan 2 booster rocket have caused another six-month setback in the first manned flight. Earlier this year he told the committee that a funding shortage had pushed the program back about six months (AW Mar. 18, p. 30).

An official of NASA's Manned Spacecraft Center at Houston, Tex., told AVIATION WEEK & SPACE TECHNOLOGY that much of the delay in Gemini could be traced to a shortage of funds last fall, when the Kennedy Administration refused to permit NASA to seek a supplemental Fiscal 1963 appropriation for Gemini and Apollo.

At that time, both the McDonnell Aircraft Corp., prime contractor for the Gemini spacecraft, and the Martin Co., builder of the Titan 2, were given "stretchout" orders by NASA. As a result, the buildup in production facilities at McDonnell was slowed down.

One of the reasons for the Administration's reluctance to seek a supplemental appropriation was the prospect of a $7 billion deficit for Fiscal 1963. The White House reasoned that it would have a less difficult time in Congress with its Fiscal 1964 budget if it held down the Fiscal 1963 deficit.

It appears that the strategy did not work in the case of the Fiscal 1964 space budget. In the same hearing at which Holmes explained the schedule changes in Gemini, members of the sub committee said flatly that there would be a cut in the budget request (AW Mar. 18, p. 30, Apr. 8, p. 32).

Holmes said the Gemini rescheduling now provides for:

- **First unmanned suborbital** flight of a Gemini spacecraft in December, 1963.
- **Addition of a second unmanned** flight, either suborbital or orbital, to be launched in mid-1964.
- **Two-man orbital flight** in the last quarter of 1964.

Holmes said the second unmanned flight was added to the schedule rather than delay the first flight to await delivery of all the capsule systems. As a result, the first flight will be with a "shell" Gemini capsule containing only guidance and control equipment and instrumentation necessary to record noise levels and aerodynamic forces acting on the spacecraft. Waiting for a completely equipped capsule would have delayed the first flight until next April or May (AW Jan. 14, p. 38).

By maintaining its schedule on the first unmanned flight, NASA hopes to detect as early as possible any spacecraft structure or guidance and control problems. Second unmanned flight would carry all the systems necessary for manned flight, including life support equipment.

Holmes said the problems encountered by NASA in man-rating the Titan 2 did not affect the rocket as a military weapon. The chief difficulty, Holmes said last week, has been the "pogo" or "chugging" effect in the early phases of flight. One objection to this is that the vibration would make reading of instruments inside the spacecraft difficult.

Holmes said the Gemini systems are "much more sophisticated than what we started out with" and that incorporation of improvements was partially responsible for the delay. He said the slips in the Gemini program would not delay the Apollo manned lunar landing flight schedule unless Gemini experience requires extensive changes in Apollo designs.

In defending the Gemini program, Holmes said "achievement of the end goal ... is the important thing ... not the intermediate milestones." The manned lunar landing is the end goal of NASA's present manned flight program.

Holmes also disclosed that Gemini costs will run much higher than originally estimated. When the program was announced in December, 1961, cost of the program was estimated at $500 million. Holmes said the projected cost now is about $700-$800 million and "it may run several million" more.

NASA had a similar experience with Mercury. When that program was announced in October, 1958, the estimated cost was about $200 million. With the Mercury program almost completed the total cost has been estimated at about $600 million.

Gemini delays may put the USAF's Boeing Dyna-Soar (X-20) orbital space glider in a more favorable light. Early this year the Air Force feared that the Dyna-Soar program would be cut back to a feasibility study (AW Feb. 25, p. 26) and some of the X-20 funds shifted to Air Force Gemini flights.

However, after Defense Secretary Robert S. McNamara visited the Boeing Co. for a personal briefing—but no hardware inspection—on Dyna-Soar development and ordered new studies of Dyna-Soar and Gemini, Air Force proponents of the program were heartened.

Testimony of Deputy Defense Secretary Roswell L. Gilpatric before the Senate space committee last week also indicated some second thoughts about dropping Dyna-Soar.

"We are not prepared to predict with certainty what the future of [Dyna-Soar] will be," he said. "We are not far enough into this joint planning operation [with NASA] or with Gemini to be sure ... whether we can rely on Gemini ... to satisfy the needs that we originally set out to accomplish in Dyna-Soar.

"Dyna-Soar and Gemini are not completely overlapping. They complement each other [and] need to be studied very carefully before we reach a decision to forego one in favor of the other or to combine the two. Military requirements ... as they develop may require separate programs."

Air Force position on Dyna-Soar has solidified under the threat of cancellation, and hardware development is going forward. About 90% of the engineering drawings on Dyna-Soar have been released to shops.

NASA's position on Dyna-Soar is that the program is desirable and will provide information on flight of a winged vehicle in space—information that will not be provided by currently approved NASA programs. Both NASA and the Air Force have prepared papers urging retention of Dyna-Soar.

Solar Probe Awards

Washington—General Electric, Martin and Philco have been awarded four month, $135,000 contracts by National Aeronautics and Space Administration to study a spacecraft subsystems and experiments for a solar probe designed to approach within 28 million mi. of the sun.

The probe will be designed to reach a distance within 0.3 astronomical unit of the sun and to sample fields, particles, radiation and other phenomena en route.

LEM Radar Contract Procedure Weighed

Washington—Grumman Aircraft Engineering Corp. will award a subcontract for the Apollo Lunar Excursion Module (LEM) radar sensor in about two months, but the firm has not decided yet whether to conduct an open competition or make the award to Radio Corp. of America.

RCA was included in Grumman's LEM proposal as the major avionics subcontractor. However, this inclusion was not binding because sensor requirements were not well defined at the time the contract award was made to Grumman.

As prime contractor, Grumman is responsible for procuring the radar package and for assuring it meets the requirements for the complete Apollo guidance and navigation system established by Massachusetts Institute of Technology. MIT is associate Apollo prime contractor for the guidance and navigation system.

There is considerable interest within the avionics industry regarding the LEM sensor package, because of its initial value—$5-$10 million—and of its growth potential.

The radar system in the lunar bug will perform two critical functions. It will provide velocity and altitude information when the bug descends to the lunar surface and range and range rate and angle and angle rate when the module leaves the lunar surface to rendezvous with the command module.

Berkner Outlines U.S. Space Goals, Argues Against Program's Critics

By C. M. Plattner

Los Angeles—Critics of the Kennedy Administration's "space race" with Russia were described by Dr. L. V. Berkner, consultant and former member of the President's Science Advisory Committee, as unrealistic in attitude and uninformed of the goals of the U.S. space program. Berkner presented his views last week before members of the Aerospace Medical Assn. at their 34th annual meeting here.

The speech, submitted to the National Aeronautics and Space Council and cleared by Vice President Lyndon Johnson, took issue with skeptics in position of national leadership and those in the scientific community, whose arguments range from waste-of-money to the premise that exploring the moon and planets can be done more effectively by instruments than man.

Berkner is president of the Graduate Research Center of the Southwest, Dallas.

Conquest of space has acquired an enormous political value, Berkner said. The nation that can win and retain space superiority will have demonstrated the superior viability of its system in the eyes of the world, he declared.

Unique space achievements by the Soviet Union, he added, could lull that nation into a false sense of superiority and overconfidence. Such a situation, Berkner said, could lead the Russians into irresponsible international adventures, perhaps leading to war.

To prevent Soviet successes, the contest for every major space objective becomes unavoidable, Berkner pointed out. Alternative to an active role in the space race could result in significantly greater costs in the future in terms of expenditures for a military deterrent.

"Because of the very primitive and deep-seated instinct to conquer the unconquerable, the space race between the U.S. and USSR is inevitable," said Berkner. "Men everywhere see, in the conquest of space, the peaceful demonstration of the superiority of one of the two competing systems of economic organization—capitalism versus communism."

A straight engineering approach to space exploration, championed by skeptics who desire that the space race be considered purely as a political race and de-emphasizing the scientific aspect to save money, presents a superficial and unrealistic attitude, Berkner said. Without the employment of the most advanced conceivable science as the tool for exploration, the space race would degenerate into a phony program.

Another reason for maintaining space-science at a high level, Berkner said, is that a straight engineering approach will work only until a serious failure is encountered, arising from natural causes not clearly understood. The program then would come to a shuddering and expensive halt, he said.

Scientific aspect of the space program is most vulnerable to budget cuts, Berkner pointed out, because to accomplish the moon program at all, the engineering aspect—building a vehicle—is essential, while the scientific programs could be trimmed.

One argument, prominent in scientific circles, Berkner said, proposes that instruments can do everything that men can do, and a lot cheaper.

Berkner countered these arguments by noting that skilled interpretation, leading to objectivity in evaluating alternate courses of action ultimately will be required. If scientists were able to build an instrument with this capability, it would look surprisingly like man, he said.

To enhance the scientific aspect of manned lunar and planetary exploration, Berkner said that young, highly skilled scientists should be included in the astronaut training program. "To do a genuine job, the astronaut team must be a well rounded team including great scientific skill," he said.

Berkner touched on another argument often heard to the effect that "just think of what we could do with $20 billion [estimated for Project Apollo] if it were turned to man's immediate welfare—medical research, housing of the poor, and so on."

More to the point, he added, we live in a dynamic civilization in which some aspects of technology must always lead others.

Failure to press these differentials will bring technology to a halt. Our space program is the greatest spur to technology today, he said.

There has been a growing tendency in recent months to view landing a man on the moon as the only goal of the U.S. space program, Berkner said, but such a belief warps the original goals.

In defining the goals of the space race, Berkner named the following categories and their associated objectives:

- **Scientific.** In addition to exploring the moon and other planets, continuing observations of the earth itself, from satellites will further determine its shape, gravitational and magnetic fields, atmosphere and its coupling into the interplanetary medium. Knowledge of the sun and of empty space will be furthered and observations of the universe, through space station-based telescopes without the filtering effect of the earth's atmosphere, will be possible. Berkner later said that the moon, since it is solid and has a natural gravity, would be preferred as a base for a space station over an orbiting body, which would be perturbed by the movement of its occupants.
- **Civil applications.** In the field of communications, world-wide direct dialing, radio and television are foreseen. Meteorological science will be further improved with satellites such as Tiros and Nimbus. A proposed satellite, called Reaper, will collect and relay information from free-floating balloons at fixed levels in the atmosphere and from floating buoys, Berkner said.
- **Military applications.** Berkner defended the right of the military in space on the basis that the U.S. must be able to counter any new weaponry techniques advanced by Russia.

McNamara Used 'Rough Judgment' on TFX

By George C. Wilson

Washington—Robert S. McNamara, the secretary of defense who insists that all available facts must be on hand before sensible decisions can be made, personally awarded the $6.5-billion F-111 (TFX) contract without the benefit of any detailed cost figures he trusted.

U.S. Comptroller General Joseph Campbell told Senate investigators last week that McNamara admitted to General Accounting Office representatives that he awarded the contract to General Dynamics-Crumman instead of the Boeing Co. on the basis of judgment "rather than independent cost studies."

McNamara said it was the kind of "rough judgment" he had made while president of the Ford Motor Co., Campbell testified.

Campbell, who heads the GAO, reported to the Senate Permanent Investigations Subcommittee probing the award of the contract that his accountants could find no independent cost basis for the F-111 contract award other than the one prepared by the Air Force, which both McNamara and the GAO probers considered inadequate.

Without mentioning his own lack of cost analyses, McNamara said in a May 1 press release that the CAO criticism of Air Force figures "strengthens my own conclusion that the Air Force cost estimates were so unreliable as an indication of the ultimate differential in research, development and production cost between the programs of the two contractors that they could not be used as a foundation for the source selection. The contractors' own cost estimates were at least equally unusable, as noted by the evaluation group."

Boeing estimated it could develop and produce 1,700 USAF and Navy aircraft for a cost of $5,364,300,000, while General Dynamics-Grumman submitted a bid of $5,455,500,000 a difference of $91.2 million. Air Force made adjustments to make the bids comparable and came up with a figure of $5,387,500,000 for Boeing and $5,803,000,000 for General Dynamics-Grumman, a difference of $415.5 million. Air Force took these contractor figures and did some projections of its own. These projections, or estimating standards, were the figures criticized by the GAO, not the contractor estimates.

Testimony last week brought out that some of the Air Force cost information McNamara is disavowing was used in the Nov. 21 memorandum of the service secretaries to justify their reversal of the USAF-Navy source selection board, which recommended Boeing for the F-111 contract four straight times.

CAO entered the F-111 controversy Apr. 2 when Subcommittee Chairman John L. McClellan (D.-Ark.) asked the agency to examine the cost estimates use by the Air Force in its F-111 evaluation. On Apr. 5, McNamara wrote Sen. McClellan that the Air Force figures "were considered so unreliable" that they were not used at the secretarial level. So, on Apr. 10, Sen. McClellan asked the CAO not only to examine Air Force estimates but "to review the cost estimates and related cost data actually used by the Secretary in reaching his decision to award the TFX contract to General Dynamics."

These were highlights of Campbell's testimony:

Campbell. Our staff has found no independent or additional cost estimates covering the TFX program as a whole, and the secretaries have advised us that none exist. Both Secretary McNamara and Secretary [Eugene M.] Zuckert have stated to our representatives that the conclusions reached by them were on the basis of their judgment rather than on independent cost studies.

Sen. Carl T. Curtis (R.-Neb.). So, while they branded the Air Force's estimates as unreliable, they made no independent or additional estimates of their own?

Campbell. That is correct. That is their statement to us.

Sen. McClellan. So that you as the comptroller general of the U.S., the General Accounting Office is unable to make an audit to find records in the Defense Dept. upon which it predicated its judgment or to substantiate the judgment and decision made by the secretary of defense in this case?

Campbell. Not with respect to costs.

Sen. McClellan. Costs being one of the reasons claimed as a justification for rejecting the lowest bid. You find nothing in the record of the secretary with respect to documents, figures, calculations, estimates to substantiate judgment, therefore, that the figures of the lowest bidder, the Boeing Co., were unrealistic with respect to cost?

Campbell. Mr. Chairman, we had no access. We did not request access because the secretary advised us that there were no records.

Sen. Henry M. Jackson (D.-Wash.). If cost realism is one of the key points, as I understand the secretary's position, along with commonality, if cost realism was a major factor in his decision, wouldn't he have to determine the validity of the cost figures as proposed by the competing companies?

Hassell B. Bell, associate director, GAO defense accounting and auditing division. Both secretaries told us they were relying upon their experience in the field previously, and that they were able to make rough judgments.

Sen. Jackson. Did they give you the procedures they followed? Not just talk. I am trying to find out here what procedures were followed.

Bell. No, sir. They gave us no detailed procedures that they followed.

Sen. Jackson. Wouldn't the sensible course of action be (if Air Force figures were considered unreliable) to have an audit made of the figures submitted by the competing companies to determine which companies submitted realistic figures? In other words, force each company to state their premise, the basis on which they had established their figures—to make them have to prove their figures one way or another?

Campbell. That is what I would do if it were possible for us. It is a very practical job to do.

Sen. Jackson. This is especially true when there was a unanimous decision four times, on a technical basis, at least, that the award should go the other way. When you are going to reverse it, you better be sure of your figures, I would think.

Sen. McClellan concluded his questioning of Campbell by saying he could not understand why McNamara, Zuckert and Navy Secretary Fred Korth kept using the cost evaluations through four rounds if they considered them unreliable. "Maybe they can answer," McClellan said. The service secretaries are expected to start testifying later this week or next.

Besides McNamara's lack of figures he considered reliable, the comptroller general's personal report to the subcommittee brought out these other points:

- **McNamara told GAO representatives** in an hour-long interview Apr. 16 that Air Force cost standards did not measure the cost differences between the competing F-111 designs, but were merely developed to test the cost realism of the proposals. He said he had taken the principal role in estimating the costs. A Defense Dept. memorandum of record of that meeting states: "The secretary said that, after finding the Air Force estimates inadequate for judging the cost implications of the two proposals, he had made rough judgments of the kind that he had made for many years with the Ford Motor Co. It did not take very much time to do this because the technical differences between the two proposals had rather obvious cost implications."
- **By employing such "rough judgments,"** McNamara on his own estimated Boeing's use of titanium would increase the per-aircraft cost by $50,000, had added $100 million to Boeing's estimate that it would cost $40 million to put thrust reversers on its aircraft, estimated Boeing's plan to hollow out some of its structural parts to save weight in the Navy version would impose a penalty of $50 million to $75 million.

According to the memorandum, McNamara concluded that "throughout, Boeing's proposals pushed the state of the art farther, greater incremental costs were inevitable because of the greater development risks and, even though impossible to quantify accurately, these costs would be substantial. The secretary said that actually the greatest risk of all lay in development of the variable sweep wing, a development common to both proposals, and that in his judgment it had not been desirable to add to this fundamental risk the differential risk involved in Boeing's proposal with respect to relatively peripheral performance items." Evaluators had concluded the Boeing design would be suponor to General Dynamics in range and bomb carrying-capacity (AW Mar. 25, p. 24).

- **Thomas E. Nunnally,** CAO staff member on loan to the subcommittee, said that on the basis of his detailed analysis of the contractors' cost estimates, "I have seen nothing to indicate that there is anything unrealistic about the Boeing proposal. There is nothing I have seen to lead me to believe that we could not have bought this airplane from the Boeing company cheaper than from General Dynamics."
- **Air Force,** when challenged by both the subcommittee and GAO investigators about its F-111 estimating standards, said its key cost analysts for those figures, Earl Crawford, was in ill health and could not be questioned. Then the night before Comptroller General Campbell was to testify, the Air Force offered to produce Crawford for questioning. But Campbell said it was too late and did not pursue it.

Also, the Air Force is still trying to work up figures to justify its estimating standards used in the F-111 evaluations. Both the subcommittee and GAO have found major errors in the calculations done at Wright-Patterson AFB. Air Force is now claiming that some of the missing supporting documents for their projections have been destroyed. Campbell said he was surprised the Wright-Patterson F-111 evaluators kept no detailed records and failed to preserve carefully what records they did have.

Boeing Urges TFX Prototype Competition

Washington—William M. Allen, president of the Boeing Co., last week said his firm could build two prototypes of the F-111 for $105 million, and recommended this as opposed to cancellation of the contract with General Dynamics-Grumman.

Senate investigators asked both firms to make prototype cost estimates after hearings disclosed that Defense Secretary Robert S. McNamara awarded the contract to General Dynamics-Grumman even after the USAF-Navy source selection board said the Boeing design would be cheaper and superior operationally.

The subcommittee asked Boeing whether it felt the contract should be cancelled or competing prototypes built. Allen said the flying competition "offers the best possibility" of assuring "the American people that the best weapons systems are being bought at the least cost." He said this competition "would permit a direct comparison and evaluation of actual aircraft built by the two competitors. Although this alternative would likely result in some increased costs, it is quite apparent that various advantages would accrue. . . ."

Allen said that the four rounds of competition in the F-111 contest degraded the 'competitive factor" and was discouraging to his company. He also assailed the civilian secretaries' charges that Boeing's proposal, though cheaper than the winning one, appeared unrealistic. "One is driven to the conclusion," Allen said, "that in future competitions a contractor should not endeavor to bid the lowest figure at which he believes he could perform the job and make a reasonable profit. Instead, a contractor should endeavor to submit a bid which coincides with the government's estimate of what it will cost the contractor to perform the job."

F-111 Subcontract

Westinghouse Electric Corp., Lima, O., will provide the primary a.c. power generating subsystem for the USAF-Navy F-111 (TFX) tactical fighter, General Dynamics announced last week.

Link to Develop Apollo Simulators For Use at Houston Center, AMR

Washington—Link Div. of General Precision, Inc., has been awarded a $9.5-million contract to develop two Apollo mission simulators to train astronauts at the Manned Spacecraft Center in Houston and at the Atlantic Missile Range.

The contract was awarded by North American Aviation, prime Apollo spacecraft contractor. The simulators will be equipped to produce sound effects simulating booster separation noise, and with lighting effects to show the earth and moon in relation to each other during mission phases.

The trainers will duplicate what the crew will see and hear during pre-launch, launch, parking and earth orbit, escape injection, coast, circumlunar pass, circular lunar orbit, lunar excursion module separation and rendezvous, injection into the trans-earth trajectory, coast re-entry and landing.

In another Apollo development, it was learned that the service module propulsion engine has a requirement for approximately 50 stops and re-starts. This Aerojet-General engine, designated AJ10-137, is the main propulsion unit for Apollo, providing midcourse velocity corrections, injection into and ejection out of lunar orbit, and small changes in the lunar orbital plane (AW Jan. 28, p. 26).

The engine is the first with a man-rated requirement to use an ablative combustion chamber, and the first with a high expansion ratio to use a thin skin radiation-cooled nozzle extension. Expansion ratio is 60:1.

Aerojet said the project feeding the greatest amount of information to the AJ10-137 is Titan 2, which uses the same hypergolic propellant. In addition, the company said the Titan program has contributed significantly to the Apollo engine injector design.

The engine operates with a pressure-fed system, and the multiple starts are accomplished simply by opening and closing propellant valves through electrical signals. Thrust tailoff can be predicted, Aerojet said, because the thrust chamber is not regeneratively-cooled, and there is no boil-off impulse from propellants remaining in the coolant tubes. In addition, there is only a small volume downstream of the propellant valves, and this is the volume which dictates the amount of tailoff impulse.

No preliminary flight rating test will be conducted for the AJ10-137. The qualification program will include firing both normally and to failure at sea level and simulated altitude.

Radiation-cooled nozzle extension, which will experience heat loads of 2,200F will have a protective coating of columbium to prevent oxidation of the base material. Titanium alloys are being used extensively for the thrust mount assembly.

Wings Added to High-Speed UH-1B Research Helicopter

Bell UH-1B high-speed research helicopter is flying with 26 76-ft-span wings as part of program sponsored by U S Army Transportation Research Command Eventual goal will be to enable the modified turbine-powered helicopter to fly at speeds of 175 200 kt Next step will be to add podded Continental J69-T9 turbojets to each side of the fuselage Wings have ground-adjustable sweep from 14 deg to 23 deg, and incidence can be rotated differentially to provide aileron control for high speed banking. Without wings the helicopter has achieved level flight speeds of 155 kt and speeds of up to 163 kt in a slight dive. High speeds were made possible by a major cleanup and drag reduction program conducted by Bell (AW Dec 10, p 52).

U.S. Seeks Industry Pay Formula

Washington — Defense Dept and space officials are trying to agree on a formula for determining whether salaries being paid by their contractors under cost-type contracts are exorbitant

Elmer B Staats, deputy director of the Budget Bureau, told the House Military Operations Subcommittee last week that such a formula was needed to give government contracting officers a yardstick for measuring the salaries intended to be paid and charged to cost. He said the Bureau had no intention of asking for statutory salary controls

In a report submitted to President Kennedy last year, the Budget Bureau said "where the contracting system does not provide built-in controls—for example, through competitive bidding—attention should be paid to the reasonableness of contractors' salaries and related benefits, and contractors should be reimbursed only for reasonable compensation costs Key question is how to decide what is reasonable and appropriate compensation" (AW July 9, p 18)

David E Bell, then Budget Bureau director, said in discussing the report before the subcommittee last year that "where the comparability standard is difficult to develop—say above the $25,000 salary level—salaries should be personally approved by an officer reporting directly to the responsible agency head" This aroused fears within the aerospace industry that the government was moving to establish salary controls

An interagency committee representing the Budget Bureau, Atomic Energy Commission, Civil Service Commission, Defense Dept and National Aeronautics and Space Administration has been trying to develop the salary yardstick Staats estimated the results of their efforts probably will be ready within 30 days

At the same hearing, Chairman Chet Holifield (D-Calif) said he was disturbed that military officers took high-paying industry jobs immediately after retirement and used their former contacts to help defense and space firms He said there should be "a two-year cooling off period" before former military officers are allowed to take jobs where their military contacts might help the contractor.

Rep Holifield said a similar period should be imposed on members of Congress after they leave office He conceded that imposing such controls on the military and Congress would be difficult, and added he had no intention of introducing legislation at the moment But, he said, "this is a tremendous problem" which should be studied intensively by the government

Nuclear Effects Study

Program to determine effects of nuclear explosions in the atmosphere on loading and response of aircraft and missile structures is planned by USAF's Aeronautical Systems Div Contractors are being sought

Initiation of the program indicates Air Force concern over the effects of large nuclear warheads used in Soviet anti-aircraft and anti-ICBM missiles

Army Attack Helicopter Plans Reoriented

By Larry Booda

Washington—Army's plan for early development of an armed escort helicopter has been sidetracked by Army Secretary Cyrus R Vance At the same time, Air Force has armed three helicopters with machine guns and is evaluating them in field trials

Vance reasoned that the Army project did not take enough advantage of improvements in the state of the art He has ruled that the vehicle now must be capable of a combat cruise speed of 200 kt instead of the 155 kt in the original specifications

Despite its recent caustic remarks about armed helicopters, Air Force has mounted machine guns on three Kaman HH-43Bs and is trying them out in the Caribbean jungles

These actions preceded a Defense Dept sponsored vertical and short take-off-and-landing conference held at Kirtland AFB, Albuquerque N M Apr 23 and 24 Representatives of the three services, industry, Defense Dept, National Aeronautics and Space Administration and Federal Aviation Agency took part Conferees discovered that the Army and Air Force were prepared to compete actively in the V/STOL field but that the Navy and Marine Corps wanted to await further developments

Steering Committee

The director of defense research and engineering will appoint a steering committee in the near future to assess various V/STOL proposals and recommend future missions and the vehicles to perform them Makeup of the committee was not announced

Defense Dept officials at the meeting indicated that their studies would concentrate on obtaining a light attack aircraft, a medium attack aircraft with higher performance than the light attack aircraft and transports. The first two would correspond to the COIN (counter-insurgency) and VAX concepts

Cancellation of the armed escort helicopter came as a blow to Army aviation enthusiasts who had hoped to have such an aircraft operational by 1965 They had received sympathetic attention in the office of the secretary of defense, especially in the office of the director of defense research and engineering Requests for proposals had been expected early in February

Whether the new specific operational requirement of 200 kt will be met by rotary wing aircraft will be up to helicopter manufacturers, an Army research and development official declared.

This speed is considered pushing the helicopter state of the art to the limit At high forward speeds, helicopters are affected by stall of the retreating rotor blade If the required speed cannot be met by helicopters, then something else must be used—perhaps a compound vehicle using both rotors and fixed wings or a VTOL vehicle, the official said He added that the speed requirement was increased because the Army believes that the helicopter can meet it

At present, the Army is using Bell UH-1B helicopters armed with machine guns for escort duty in South Vietnam It was hoped that a newly developed helicopter designed from the beginning to perform the mission would be available to replace the UH-1B beginning in 1965 Now, the earliest estimated time under the new requirements would be four years after proposals are received For instance, if evaluation of proposals were begun this summer, the deployment time would be 1967.

R&D Victory

Within the Army the Vance decision is considered a victory for the research and development faction. The losers are those in requirements planning who wanted faster action The result will be a slower approach to the project and a vehicle with improved operational capabilities

Air Force has been outspoken in its contention that fixed wing aircraft are better suited to perform the escort mission Its action in modifying the HH-43B is believed to be an objective attempt to test the capabilities of such a vehicle against ground forces in jungle terrain

The three aircraft were modified by the Combat Developments Group at Eglin AFB Fla

If this type aircraft is found to be suited for the mission, then the Air Force intends to claim that it should perform the escort job with it

At the Albuquerque meeting, the Army proposed pursuing applied research in V/STOL aircraft by having flying testbeds representing a number of approaches to the problem. This would be an extension of current programs Compound vehicles were emphasized in the presentations V/STOL transports will be in 3 to 4-ton payload category

Army-USAF Battle

It was clear that the area of close support and forward area transport would be the principal roles and missions battleground between the Army and Air Force (AW Jan 14, p 26) Both services have decided to follow the V/STOL concept in future close air support and to a lesser degree in transport vehicles The secretary of defense will have to resolve the differences eventually

In addition, the Air Force proposed a vertical takeoff fighter concept It could be a supersonic aircraft No specific mission or requirement exists now for such an aircraft Air Force will concentrate on a 10-ton payload transport capability.

The "wait and see" stand taken by the Navy was influenced by the heavy commitment the Navy now has for fixed-wing aircraft operating from its carriers. Defense Secretary Robert S McNamara had given strong hints in congressional testimony that VTOL aircraft could fulfill the anti-submarine mission in the future, but Navy has shown little enthusiasm

The Marine Corps has a specific operational requirement for an STOL aircraft that would act as helicopter escort and for close support in jungle terrain The proposed light counter-insurgency aircraft would fill the Marine Corps' need

MA-9 Canisters Returned to Cape

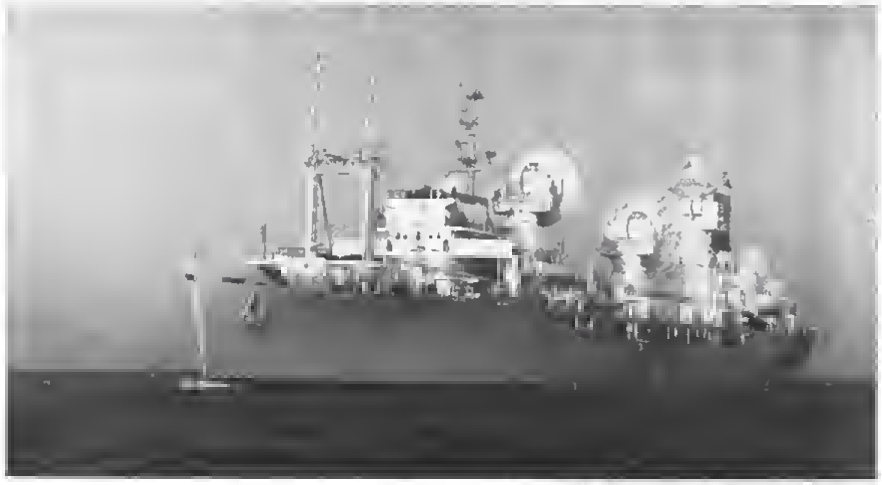
All three gyro canisters of Atlas 130 D, the booster for Mercury Atlas 9 (MA 9), have been returned to Cape Canaveral Fla by General Precision, Inc., the canister manufacturer, and have satisfactorily passed all tests to date.

Canisters, part of the capsule's autopilot system were removed when bits of solder were discovered in the gimbal blocks (AW Apr 29, p 25) Each of the three canisters had undergone a rigorous set of laboratory tests by the middle of last week.

Two of the canisters have been mounted on the Atlas and checked out as part of the total launch vehicle system. First set of gyros to be installed on 130 D was removed after successful checkout, this is the flight-ready spare canister Canister intended for the actual flight remained on the booster after successful checkout

Third set is subjected only to lab tests and would not be checked as part of the launch vehicle unless one of the other two fails between now and May 14, the scheduled launch date.

National Aeronautics and Space Administration was scheduled to complete its joint FAC (flight acceptance composite) test of the mated Atlas and Mercury capsule by late last week. Capsule and booster were mated Apr 22



AIR FORCE'S GEN. H. H. ARNOLD is shown sailing on its checkout cruise, prior to assuming its post on the Atlantic Missile Range.

First AMR Tracking Ship Begins Checkout

By George Alexander

Cape Canaveral, Fla.—First of the Air Force's Advanced Range Instrumentation Ships (ARIS), the Gen H H Arnold, sailed from here last week for a two month checkout cruise prior to assuming its role as the newest and southernmost station of the Atlantic Missile Range.

The Arnold will operate in the vicinity of Grand Bahama Island for the next two months, tracking all military and civilian launches in this time period and evaluating the performance of its radar and telemetry systems.

When this checkout exercise is completed, the Arnold will steam south and take up a position between Ascension Island, the last AMR land based tracking station, and the east coast of South Africa, about 10,000 mi. from the Cape. This is the range limit of present U S intercontinental ballistic missiles.

Ships have been used in this South Atlantic-Indian Ocean area before, usually in conjunction with a specific launch or series of launches. These vessels lacked the tracking capabilities of the Arnold, with its C-, X- and L-band radars.

The Arnold provides the first site, fixed or mobile, on the Atlantic range able to track multiple targets with multiple frequencies. It is, according to one engineer, the equivalent of, or better than any present land station.

The Arnold will be able to stay on station for as long as seven weeks at a time; it will return to the Cape only for overhaul.

Primary mission of the vessel, which has been converted by Sperry Gyroscope Co. from a World War 2 troopship into a floating tracking station (AW June 11, p. 101), will be the gathering of data on military re-entry vehicles and associated decoy and penetration aid programs.

In this capacity, it will play a major role in the Abres (advanced ballistic re-entry systems) program (AW Dec. 10, p. 27), since the ship will be able to monitor re-entry of a nose cone in the immediate impact area.

The ship will be positioned either broadside or head-on to the trajectory plane of a nose cone and observe those characteristics of a re-entry vehicle which are indices of its effectiveness.

- **Plasma sheath.**
- **Ion enhancement** and electron density.
- **Wake turbulence**, length and separation from the body of the cone.
- **Weight-to-drag ratios.**
- **Target size enhancement.**

All of these phenomena are sensitive to different frequencies. They reflect certain wavelengths well and are nearly invisible to others. The C-band radar, a pulse-compression type, will track both the C-band beacon (5,400-5,900 mc.) carried by a re-entry vehicle, as well as the skin of the cone. The beacon is a research and development item intended to aid downrange stations in acquiring the cone.

C-band radar has two identical transmitters developed by Avco Corp.'s Electronics Div. Both alternately transmit vertical and horizontal polarized beams, one tracks while the other gathers data. Each generates a 1-mw., 30-microsecond-long pulse. This is 30 joules of energy applied to the target being tracked—considerably more energy than that generated by any other radar in use on the range at present.

The FPS-16 aboard the Twin Falls Victory, a short-range vessel used during the Army Pershing missile program, put out about 0.25 joules and the land-based FPQ-6 between 3 and 9 joules. It is this higher energy level which permits the Arnold to make more definitive measurements of re-entry bodies than previously possible at AMR.

On a normal flight, radar contact is expected to be made with a cone about 4 min. before impact, well before re-entry begins. The C-band radar will lock on the re-entry vehicle and, through a servo link, drive the X- and L-band systems to acquire the cone also. X- and L-band transmitters share a 40-ft.-dia. antenna, with the former using the center segment out to a diameter of 18 ft. and the latter using the remainder of the dish. C-band antenna is a 30-ft.-dia. parabolic dish.

Since only the C-band radar is a true tracker, loss or failure of it also would result in loss of the other two systems' lock-on. A switch device, however, would cause the second of the C-band's two transmitters to assume both functions of tracking and data gathering if the first should fail. X- and L-band radars also have dual transmitters.

All three radars on the Arnold are of the pulse type and have been developed specially for the ARIS program by Sperry. Each has a look angle of 130 deg. on either side of the ship's centerline and may be elevated from 0 through 90 deg. Slew rate in any direction is 30 deg./sec.

Second ARIS

Second ARIS (Advanced Range Instrumentation Ship), to be delivered by Sperry Gyroscope Co. to USAF this summer at Cape Canaveral, Fla., will mount an ultra-high frequency (UHF) radar system in place of the X-band system aboard the first vessel, the Gen. H. H. Arnold.

Signal enhancement is better at lower frequencies.

Radar Video Recorder

Radar video recorder, still under development by Federal Laboratories Div. of International Telephone & Telegraph Corp., and not expected to be installed aboard the Arnold until later this year, combines the signals received by all three radars in digital form on a tape for later analysis. A separate tape recorder stores data gathered on the 30-ft.-dia. telemetry antenna. A total of about 140 million bits of data will be taken off each ballistic flight.

Telemetry data will be re-transmitted after the flight over a whip antenna to a courier aircraft near the ship. The plane will re-record the data and then fly it to a land station for reduction and analysis. Tracking data will be transmitted over specially developed helical antennas (medium- and high-frequency) back to Cape Canaveral.

A high-speed data transmission link is not presently funded and, therefore, not aboard the Arnold. Tracking data will be sent—at least initially—at about 50 bits per second over a teletype channel.

Value of the high speed link is that it would allow the Arnold to return tracking data in virtual real-time so that the Cape technicians could, if necessary, send corrective impact prediction commands to the stage of the missile still burning. Range of the radars is sufficient to pick up a missile as it comes over the horizon with an upper stage still burning.

Voice, data and teletype communications systems, covering a range of 15 kc. to 400 mc., have been developed by ITT to provide high-frequency (HF) channels for normal voice and teletype, very high-frequency (VHF) and ultra-high-frequency (UHF) channels for short-range ship-to-ship, ship-to-shore and ship-to-aircraft links, and very-low-frequency (VLF) for reception only. There are one 10-kw. and two 2.5-kw. HF transmitters radiating from the helical antennas.

ITT also developed the high-directional telemetry antenna, which can be operated either independently of, or in consort with, the radars. This 30-ft.-dia. dish can receive either wideband signals between 200 and 1,000 mc. or narrowband signals at 13,000 mc. for special missions. It has a manual-scan capability, but normally will be aimed at a sector where the nose cone can be expected, based on pre-computed trajectories. It should acquire the cone's beacon first and zero the C-band radar in on the target, although the opposite mode also is possible.

The telemetry antenna can be slewed at a rate of 0.5 rad./sec. Telemetry signals received by the antenna are recorded on tape in raw (pre-detection) form and also re-transmitted in this form after the nose cone has impacted in the ocean.

ITT also is responsible for the timing system aboard the Arnold. It is synchronized within 0.01 sec. of Cape Canaveral time and is accurate within five parts in 10 billion per day. The system receives HF signals from the Naval Observatory's Station WWV at Washington, D.C., and LF signals, when out of range of WWV, from the National Bureau of Standard's Station NBA, at Washington, D.C., and Boulder, Colo.

The Arnold also carries a meteorological system, including weather rockets, balloons and conventional instruments. Rockets are Atlantic Research Corp. Arcas rocketsondes. One will be fired after the completion of each mission to gather data on the atmosphere up to an altitude of 125,000 ft. All weather data will be used to correct anomalies induced by weather in the radar recordings received during a nose cone flight.

Data handling system consists of a Univac 1206 digital computer and a central data conversion and control console. All raw data—from radars, telemetry antenna and the ship's guidance system—is digitalized by the converter and fed into the computer. It can either be stored there on tape or used in computations. The Arnold can transmit raw data or computations back to the Cape over the HF link.

Inertial Navigation

The ship's inertial navigation system (SINS), similar to that used on Polaris submarines, establishes an inertial reference for all radar and telemetry antennas. All pointing directions of these antennas are referenced to this platform and not to local verticals or horizontals.

In tracking a nose cone, the computer will receive inputs on the angular reflections of the antennas and pitch, roll and yaw motions of the ship, as detected by the SINS. Later, when reducing the data, the ship's motion readings will be extracted from the deflections of the antennas so that the data will appear to have been gathered from a fixed and stable platform.

Computer serves several functions. It is the interface between radars, telemetry and the SINS. It predicts the trajectory of the nose cone so that if track is momentarily lost, the C-band radar will know where to look for re-acquisition. It also prepares data for re-transmission back to the Cape and computes data gathered by a star-tracker (part of the SINS) for rechecking the SINS' accuracy.

For other than re-entry missions, the Arnold can be used to track earth satellites and space probes. It would use only the telemetry antenna and the C-band radar for these secondary missions. Engineers say that it would be more effective in conjunction with earth satellites than probes because of the extreme range required for deep-space radars.

Titan 2 Tracked

Cape Canaveral — Telemetry system aboard the Gen. H. H. Arnold USAF's newest and most advanced range instrumentation ship, was used to gather data from a Martin Co. Titan 2 ICBM launched Apr. 19, when normal ground receivers here suddenly failed about 15 sec. after the missile lifted off.

The Arnold was docked in Port Canaveral, immediately adjacent to and south of the Missile Test Center, having arrived here from the Brooklyn Navy Yard Apr. 2. Engineers from International Telephone & Telegraph Corp.'s Federal Laboratories manufacturer of the telemetry system, had been exercising the 30-ft.-dia. dish antenna against different missiles launched from the Cape.

Shortly after the Titan 2 was launched, all regular Cape telemetry contacts with the missile were lost. This was not known to the ITT engineers at that time.

They trained their shipboard antenna on the missile, tracking it on two channels and receiving data on five other links. The system held a lock on the Titan 2 for more than 15 min. after launch, or until the vehicle went over the horizon about 3,000 mi. downrange.

Data tapes later handed over to USAF and Martin were said to be usable.

High Orbit, Redesign to Improve Telstar 2

By Philip J Klass

Washington—Improvements in Telstar 2, scheduled for launch this week are intended to make the communication satellite less vulnerable to space radiation damage than Telstar 1, which malfunctioned after about 4½ months in orbit

This, coupled with a higher apogee—6,560 mi vs Telstar 1's 3,531 mi—should give Telstar 2 a longer operating life

The higher apogee, made possible by an improved Thor-Delta booster, will reduce the time Telstar 2 is exposed to high intensity electrons and protons produced by the July 9 Starfish nuclear test

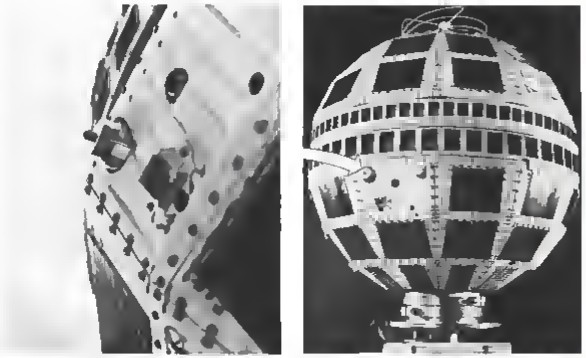
The higher apogee also will provide an average of about 50% longer operating intervals when the satellite is visible to both U S and European stations although this will result in fewer passes per day Orbital period will be 221 min vs 158 min for Telstar 1 Telstar 2, like its predecessor, was built by Bell Telephone Laboratories and the cost of the satellite and its launch from Cape Canaveral by the National Aeronautics and Space Administration will be paid for by the American Telephone & Telegraph Co

Radiation Report

Telstar 2's orbit is expected to enable it to report on radiation in the outer Van Allen belt and the slot between the two belts, a region not penetrated by Telstar 1 Radiation measurement devices on Telstar 2 differ from those in the earlier version in their range of sensitivity Where Telstar 1's electron detector had a measurement range of ¼ to 1 million electron volts (mev), Telstar 2 will be sensitive in the range from ¾ to 2 mev, and it will make omnidirectional measurements where Telstar 1 was limited to a 20-deg cone One of three proton detectors has been modified to lower its threshold sensitivity from 25 mev to 17, a value which Telstar 1 data indicated was the most harmful range for solar cells

The cause of Telstar's initial malfunction, which prevented ground stations from turning on the satellite transmitter, has been diagnosed as due to ionization of gases and air within command decoder transistor cases (AW Jan 21, p 85)

To obtain confirmation of this diagnosis, one of the two command decoders in Telstar 2 will use transistors in which the enclosure has been evacuated and sealed in a vacuum to eliminate this source of damage



GOLD SCATTER DOME that covers electron detector is shown on close up of Telstar 2 panel (left) Device allows measurement of electrons in 750,000 to two million electron volt range Telstar 2 (right) weighs 175 lb and has a 34½ in -dia Position of the gold scatter dome is shown by arrow in photo at right

The operational lifetime of Telstar 2 is expected to provide a valuable measure of the reliability that can be obtained in moderately complex spacecraft payloads with present state-of-the-art Components used in the new satellite have undergone far more extensive life tests and selection procedures than those used in Telstar 1 Because the initial cost of creating a military or civil communication satellite system and the subsequent annual operating costs are heavily dependent upon mean time - between - failure of satellites in orbit, Telstar 2's performance will be closely watched both by Defense Dept and by new Communications Satellite Corp officials

Telstar 2 will weigh 175 lb five pounds more than its predecessor Its telemetry will report back on the performance of 118 items, six more than the earlier model These include measurements on the command circuit and a more precise measure of pressure within the spacecraft The satellite is designed to permit telemetry data to be transmitted at 4,080 mc, the frequency used for its tracking beacon as well as the customary 136 mc telemetry frequency

This will permit Telstar 2 to continue its telemetry reports beyond the two-year period allotted by NASA for its operation when the 136 mc beacon will automatically shut down

Station Changes

Several changes also have been introduced into the AT&T ground station at Andover, Me, to improve satellite performance Where formerly the giant horn antenna was directed by signals from a command tracker, precision tracker and magnetic tapes—with the horn antenna's automatic tracking circuit used only to correct for minor alignment errors—automatic tracking from the satellite signal itself now will be the primary aiming means

Future plans call for installation of a new low noise maser amplifier at Andover, using a superconducting magnet and closed-cycle cooling system, which will increase the receiver's operating bandwidth from 25 mc to 50 mc

Synchronous Satellite

Los Angeles—Feasibility of using a spin-stabilized space vehicle as a synchronous meteorological satellite is being investigated by Hughes Aircraft Co under a $60,000 contract from the Goddard Space Flight Center of the National Aeronautics and Space Administration

Hughes has championed the spin stabilized vehicle concept for the synchronous communications satellite application and incorporated it in the NASA Syncom satellite program (AW Aug 20, 1962, p 80). In its meteorological satellite study, the company will try to determine whether a spin-stabilized vehicle like Syncom controlled by gas jets and carrying a camera can perform the meteorological synchronous satellite mission that might otherwise be intended for a three-axis attitude-controlled vehicle

Republic Aviation has been working under NASA contract on a synchronous meteorological satellite

USAF to Propose Long-Endurance Aircraft

Washington—USAF proposal to build a multi-purpose, long endurance aircraft (Maple) will be submitted soon for Defense Secretary Robert S. McNamara's approval.

McNamara's conviction that the next generation of strategic aircraft must be missile launching platforms that can stay aloft for days at a time prompted the Aeronautical Systems Div. at Wright Patterson AFB to resurrect and refine the Dromedary concept into a definite proposal (AW Feb. 18, p. 40).

Air Force Systems Command and the Strategic Air Command have been involved in Project Maple for several months. Next step is for the Aeronautical Systems Div. to send the proposal to Air Force Systems Command, which will then forward it to the Pentagon. Air Force officials estimate the proposal will reach McNamara in about two months.

As Project Maple sets forth specific requirements for the long-endurance aircraft, Air Force would be able to solicit industry bids almost immediately if McNamara approves. The attitude of Congress toward building another generation of strategic aircraft before placing primary reliance on ICBMs is extremely favorable, as demonstrated by repeated lopsided votes urging extending the life of manned bombers.

McNamara's Stand

In refusing to expand bomber development beyond the three-aircraft USAF North American RS-70 program, McNamara has argued that land sites and submarines are far better missile launching platforms than aircraft. However, he has displayed interest in aircraft that could achieve some invulnerability by staying aloft for extended periods to avoid being destroyed on the ground by a surprise missile attack.

As for future bombing requirements, the defense secretary contends these can be fulfilled by tactical fighter-bombers such as the existing McDonnell F-4B Phantom 2 and the planned General Dynamics Cruminan F-111 (TFX). This is his answer to congressional charges that the U.S. will have no strategic bombing capability once the Boeing B-52s and General Dynamics B-58s wear out.

"I do not know any responsible civilian or military leaders in the Defense Dept.," McNamara told the Senate Defense Appropriations Subcommittee, "who believe we can use free fall bombs as a means of delivering warheads on the Soviet targets in the decade of the 70s. ... Airplane launch of a missile is the most complicated way to launch a missile because the airplane is moving rapidly, changing dimensions rapidly in a three-dimensional environment. ... So there is no question in my mind that it is far easier and far more reliable and far less costly to develop either a sea launch platform or a ground launch platform for the launch of missiles. The use of aircraft, if they are used at all for the delivery of warheads for strategic purposes, must be used in conjunction with missiles."

This writing off of the aircraft as a strategic weapon still worries several influential members of Congress, despite the numerous explanations McNamara has given in both closed and open hearings this year. Some call his rigid policy against extending the life of manned bombers "Maginot Line" thinking. This criticism probably enhances the chances for Project Maple, because McNamara's approval would ease the minds of those who feel the U.S. is relying too heavily on unproved missiles.

USAF Chief of Staff Gen. Curtis LeMay, discussing the Dromedary concept in recent hearings told Congress: "We think we can build one now that will fly 48 hr." Air Force Secretary Eugene Zuckert said his service's basic philosophy is that "there will be a requirement for a manned system" beyond the Boeing B-52 bomber "and we should get on with it."

An exchange between McNamara and Chairman A. S. Monroney (D-Okla.) of the Senate aviation subcommittee, during discussion of the Fiscal 1964 defense budget on Apr. 25, demonstrated very clearly how the defense secretary feels about the future of strategic aircraft. Following is part of that exchange:

Sen. Monroney: I am very disturbed because you have spoken in the hearings about the fact that we may fight a conventional war. If we find ourselves at close quarters in Western Europe and it is held to non-nuclear, we do not have any ICBMs or IRBMs that are worth a tinker's dam for carrying conventional warheads, do we?

McNamara: Absolutely not.

Sen. Monroney: So if we let our manned bomber forces become totally obsolete, and it is becoming more that way more and more each day, will we have a response to non nuclear threat with our air power? Granted we have it with the B-52s, B-47s today and some of the B-58s, but some of these are getting pretty darn old. I doubt very seriously if you are going to be very satisfied with a B-52 in the year 1968.

McNamara: The 47s, 52s and 58s were never really intended for use in the carrying of conventional ordnance. As a matter of fact, most of them do not have any capability for that. At the time of the Berlin crisis we purchased, if I remember correctly, 250 sets of bomb racks for conventional ordnance in B-47s, but it was just a one-time emergency use. There has never been any real intention to use that type of bomber for conventional ordnance-carrying purposes. But we do have great capability for bombing with conventional ordnance from our F4Hs [F-4Bs] which are the backbone of the Naval fighter force.

Sen. Monroney: It is still a tactical bomber?

McNamara: Yes, but it would be the kind of bomber that you would use in conventional war if you entered such war on any extensive bombing scale. Similarly, the TFX, which will be the follow-on to the F4H, will be both a nuclear and non-nuclear bomber with a bomb load capability something on the order of 15,000 lb. and with rather extended ranges, substantially greater than the F4H.

Sen. Monroney: That is not a strategic range?

McNamara: No.

Sen. Monroney: You could not stand off out of danger.

McNamara: I think it very unlikely that we would utilize strategic weapons with conventional warheads.

Monroney Opinion

Sen. Monroney: Granted you have grave doubts about the RS-70. Many of us have some doubts about it being a good weapons system. But we ought to have something, I think, on the drawing boards or being tested to be in between this [existing bomber fleet and the RS-70]. Maybe we do not have to go to Mach 3 to get a good bomber. But a country as great as this I don't think, can use a 1955 or 1957 plane in the year 1968 and say we do have the conventional ... manned bomber capabilities. I just wonder why the military services have not had some blueprints made and a prototype or two of something between the RS-70 and our rapidly aging B-47s, B-52s and B-58s.

McNamara: I think the Air Force is inclined to believe that to the extent that a manned aircraft would be used for strategic purposes in the future it should be equipped with missiles and stand-off missiles. Probably [the aircraft would be] long endurance because the aircraft launch platform is highly

Titon 2 Lounched From Silo ot Vondenberg AFB

Titan 2 intercontinental ballistic missile leaves silo at Vandenberg AFB, Calif., to start on a 5,000 mi flight down the Pacific Missile Range Apr 27. Launch silo was 146 ft deep. Launch was jointly conducted by members of Air Force Systems Command, Strategic Air Command and by employes of the Martin Co., missile manufacturer.

vulnerable on the ground to missile attack. If we are talking of a period toward the latter part of this decade, 1968-70, into the following decade, we must anticipate that submarine-launched missiles or others coming with very little if any, warning will very probably destroy the majority of aircraft on the ground. Therefore if aircraft launch platforms are to survive, they must be in the air to survive. Hence, the Air Force is examining the possibility of a long endurance aircraft for the launch of stand-off missiles.

Sen. Monroney: It seems to me we are gambling more than we should gamble in not at least having one plane prototype [developed] and tested, that we could afford to mass produce in quantity in the event that we are faced with a situation that would still demand [such an aircraft]. As modern warfare demands a torpedo boat.

McNamara: The problem is one of finding a system that is not so complicated that its reliability is in question. Air Force is seeking to meet problems of mating a reliable missile, reliable guidance system and survivable launch platform. We are working on it. I do not know whether we are going to come up with anything that will be successful. The Air Force is definitely considering it. I asked them in a memo last October to give thought to this. They are doing so. I think it is important to recognize that these air launched missiles under the best of circumstances would be only supplementary devices to the main force: the great megatonnage of the force that will be delivered by land-launched or sea-launched missiles under any circumstances. There is no plan in the Air Force that I know of, or no thought of any plan, to substitute air-launch for sea and land launch for the great bulk of the megatonnage.

Sen. Monroney: But we are still going to keep interceptors and DEW Line and Pine Tree and everything [for Russian aircraft which might follow] a missile attack.

McNamara: However, the latest national intelligence estimates indicate there will be a decline in the Soviet bomber force and one far earlier than a decline in our force.

Sen. Monroney: I would still like to see a development of a good fast plane somewhere between Mach 1 and 2 with bomb-carrying capability, both conventional and nuclear, to replace these very reliable and effective and successful bombers that have helped keep the peace of the world in the past. We never had to fight a war with ICBMs. I hope we never do. I hope they will all work perfectly as they are designed to do. But I still would like to have that extra reserve, and a good modern aircraft, which would be even a fractional part of what it would cost to design an airborne missile that would be mounted on the airframe itself.

McNamara: We may well be able to bring such a program to you next year.

Sen. Monroney: It is getting later than you think.

McNamara: There is no proposal in the Air Force or anywhere else in the Defense Dept. to my knowledge to undertake further development of conventional bombers. There are proposals under way to develop the possibility of launching nuclear warheads from aircraft. It is those, I think, we will continue to work on and hopefully accomplish some of the objectives you have in mind.

Sen. Monroney: Would you say with the state of the art in miniaturization of a nuclear package that there would be a possibility of obtaining perhaps a Mach 3 small bomber that would get through that would be more practical than a huge plane that is sort of designed to be a super dreadnaught? In other words, to have 10 trying to get through rather than one, and maybe your investment being no greater in the 10 than in the one?

McNamara: I think it would be the conclusion of the experts on this subject that for strategic bombing purposes, and by that I mean against the heartland of an attacker, it would be necessary, no matter what the speed of the bomber, to launch standing off from the target at a considerable distance because of the weight and mass and accuracy of the air defense.

Cosmos 16 Launched

Moscow — Soviet Union announced that Cosmos 16 was launched Apr. 28 into an orbit ranging from 248.6 to 128.3 mi. The satellite, whose purpose was described as "continuing space research," was orbiting the earth every 90.4 min. at an inclination of 65.01 deg. to the equator. It reportedly was transmitting on a frequency of 19.996 mc.

Cosmos 16 is the eighth satellite in the Cosmos series to be launched at a 65 deg. inclination, probably from Tyuratam east of the Aral Sea (AW Apr. 29, p. 22). It was the sixth Soviet space launching this year, as compared with nine for the U.S.

'Intuitive' Nuclear Carrier Study Rejected

Washington—Defense Secretary Robert S. McNamara has told the Navy it was "intuitive" rather than "quantitative" in its most recent attempt to justify nuclear powered aircraft carriers, and has told it to try again.

The study was part of an over-all review of fleet striking power and air defense by a sea-based strike forces study group (AW Apr. 15, p. 37).

As part of its study of the tactical mission area this group also has ordered flight tests of low-level penetration methods, which will force the air force to defend its own low-level mission concepts. Both services agree on the low-level approach to avoid increasingly improving radar detection. But they disagree on the best altitude for avoiding detection without making too severe a demand on terrain clearance radar. Navy has chosen 150 ft. as the optimum altitude while Air Force prefers 500 ft.

An eight-page memorandum signed by McNamara not only ordered the Navy to conduct another study of nuclear carriers but gave detailed instructions on how to prepare the information so it would satisfy defense cost-effectiveness requirements.

Vice Adm. William A. Schoech is chairman of the study group and of its air strike panel. Rear Adm. John B. Colwell is chairman of the panel studying nuclear power. The latter panel, composed mostly of officers from the Navy's Long-Range Objectives Group, which Adm. Colwell heads, was the target of the McNamara memorandum.

Original Task

The study group originally had been told to assume that a certain unspecified sum would be available through 1970 for aircraft carriers. It could choose a figure which it thought would provide enough carriers to maintain force levels for the period. Its task was to show comparative performance of nuclear-powered carriers and conventionally powered carriers.

For example, it could use the western Pacific area around Southeast Asia to show comparative operating efficiencies because the factor of distance combined with logistic support is almost at its limit there.

The studies submitted included some of these comparisons but did not include detailed figures for a number of alternative situations, such as varying times of deployment in the operational areas and intensity of operations. Thus the "quantitative" factor was missing.

But the fundamental McNamara objection was that the group compared equal numbers of nuclear-powered and conventionally powered carriers.

The McNamara memorandum pointed out that for a given sum of money, fewer nuclear powered carriers could be bought. The proportion might be three conventionally powered carriers matched with two having nuclear power. This would be the figure if nuclear power increased carrier cost by one third. If the increase in cost were 20%, which the group believes could be achieved by using four reactors instead of eight and newer, more efficient plants, then the comparison would be about six conventional carriers against five with nuclear power.

The group will have to conduct detailed war games on computers using a number of different "scenarios" representing varying operational conditions to provide the detailed statistics demanded by McNamara.

By contrast, the air strike panel studies have had smooth sailing as far as the office of the secretary of defense is concerned. There have been daily consultations with a defense representative who is a member of a steering group, which helps to assure favorable consideration of study results when they are submitted sometime after May 15.

The air strike panel has studied many different types of missions, but low-level flight has received most of its attention. Improvements in Russian radar, which also is in the hands of the satellite countries, is expected to make high level penetration of an enemy-controlled area unfeasible after 1964.

The Navy studies showed that 150 ft. was an ideal altitude, well within the capability of clearance radars now being installed in the Douglas A-4E attack aircraft and the McDonnell F-4B fighter. To see whether the studies are correct, Navy's Experimental Squadron Five is now flying low-level missions against ground radars with F4Bs.

Air Force Tests

Because it has said that 500 ft. was the optimum altitude, the Air Force will be told by Defense Dept. that it, too, should run comparison tests. They are expected to begin soon. No determination has been made of what aircraft will be used.

Behind the Navy's studies to justify nuclear power for carriers and other large ships is the fact that Vice Adm. Hyman Rickover, the Navy's nuclear power expert, has convinced McNamara that oil power is obsolete for large ships. But McNamara wants to be shown figures to support this view, especially for the purpose of convincing Congress when another nuclear-powered carrier is included in budget requests.

Apollo Launch Escape System Test Fired

Rockets in the Apollo launch escape system fire during the first tie-down test firing recently at Lockheed Propulsion Co.'s facility near Beaumont, Calif. Four canted nozzles of the system fire downward. Pitch control motor at top would control flight path of the Apollo capsule if the escape system were actuated during boost phase.

Soviets Parade Missile Arsenal; May Day Speech Takes Softer Line

By Herbert J. Coleman

Moscow—Soviet defense establishment, in an eleven minute segment of a three-hour May Day parade, last week rolled its now well established missile armory at 30 mph through Red Square past honored guest Cuban Premier Fidel Castro.

Hardware ranged from the now aging Shyster missile and its follow-on version, the Sandal which was deployed in Cuba, to the newest weapon on display, the Polaris-type ballistic missile code named Snark (AW Nov 26, p 34). Snark was first shown in Moscow during last November's anniversary celebration of the Bolshevik Revolution.

No major modifications were evident on the Snark, but the May Day parade included a second identical missile. Both were drawn by a prime-mover based on the Soviet T-54 tank, with 16 sailors on bench seats.

Other missiles which took part in display, all of which were shown in past parades, included:

- **SA-2 and SA-3 Guideline** anti-aircraft missiles. SA-2 is radar guided with an operational height of about 80,000 ft., and SA-3 is designed to attack low-flying aircraft, similar to the U. S. Hawk missile. There are at least 24 SA-2 sites in Cuba.
- **Shaddock** missile, which is hauled in a cylindrical container of which no details are available. Cylinder is about 35 ft. long and apparently serves as a launch tube; entire unit is hauled by a truck and the missile itself rests on a four-wheel trailer. Forward section of the cylinder is open, disclosing only a pointed, red nose cone.
- **Number of small trucks** mounting wire-guided Snapper missiles (AW Mar. 11, p. 92) each with cruciform wings about midsection, and used as anti-tank weapons. Missiles are mounted on carrier's aft-section in a bank of three.
- **Usual array of unguided artillery** rockets mounted on tank chassis. The artillery weapon has six fixed fins and is spin stabilized in flight.

Military section was first reviewed by Soviet Defense Minister Rodion Malinovsky. Three service attaches from the U. S. Embassy as well as Ambassador Foy D. Kohler and top aides were missing from Red Square because of Castro's presence and a feared possibility of remarks being made which could cause "embarrassment."

Following standard Soviet May Day practice, the only speech was made by Malinovsky who took a surprisingly soft line considering his rocket rattling outburst at the Red Army Day celebration earlier this year.

The Defense Minister addressed the Moscow garrison, commanded by General Beloborodov, from the mausoleum and during his talk said USSR is waging a persistent struggle for general and complete disarmament, under what he called strict international control, for a ban on production and tests of nuclear weapons and for a negotiated settlement of all questions at issue.

However, Malinovsky continued, the USSR considers that the danger of a new world war is not over and stressed that the current international situation demands that the Soviet Union increase in every way the economic and armed might of the nation, keeping its forces in full combat readiness.

He also said:

"Reactionary circles of the U. S. and their satellites are carrying on an aggressive policy, espionage and are organizing different aggressive blocs such as NATO."

In addition Malinovsky charged the U. S. with carrying on a policy of aggression and provocation towards Cuba, adding:

"The Soviet army, together with armies of other socialist countries, is going to give a decisive and complete defeat to any aggressor if he dares to attack the peace, freedom and independence of the USSR and other socialist countries."

Opening the May Day military demonstration was a marching unit of paratroops followed by a line of light tanks, all with paratroop insignia. Army section included a number of heavy tanks and field guns, and unguided rockets.

Parade closed with Sandal and Shyster missiles with nozzle sections closed off by covers. There were no external changes in the weapons.

Boeing Strike Delayed Pending IAM Vote

Washington—International Assn. of Machinists last week "temporarily postponed" a coast-to-coast strike against the Boeing Co. pending outcome of a vote on ratification of an agreement only slightly changed from the pact rejected earlier by the membership (AW Apr. 29, p. 27).

The government, through the Federal Mediation and Conciliation Service, exerted strong pressure on the union to come to terms with the company after IAM leaders issued a strike call Apr. 29. The pressure included a telegram from President Kennedy to IAM's president, A. J. Hayes urging the new vote.

After IAM members refused by more than 800 votes to ratify a new three-year contract with Boeing, the leadership scheduled a strike to start May 2 at Capt. Canaveral, where about 200 IAM workers are employed at Boeing Minuteman launch facilities. It was to spread, day by day, to Boeing Wichita plant, to Strategic Air Command bases where Boeing employes are installing Minuteman missiles to the Huntsville, Ala., Marshall Space Flight Center, to the Michoud, La., Saturn assembly plant of the National Aeronautics and Space Administration, and then to Boeing's Seattle and Ogden facilities.

DOD was apprehensive that in addition to the problems created by a strike of Boeing IAM workers, there was a likelihood of sympathy walkouts by IAM workers at other aerospace firms and of building trades union workers at missile sites.

The new contract agreed upon by Boeing and IAM leaders culminated more than nine months of negotiations during which President Kennedy invoked the 80-day Taft-Hartley law injunction to avert a strike. The injunction expired Apr. 15, leaving the federal government without further legal recourse to prevent a strike.

The contract was approved by a margin of about 3 500 at Boeing's Seattle plant but the over-all vote was 9,591 to 8,723 against ratification.

Boeing management complained that some IAM leaders failed to inform the membership properly on the contract's terms, notably at the Wichita plant, where ratification was overwhelmingly voted down.

The new agreement which will be put to a ratification vote May 10, includes variations, but no basic changes, from provisions of the defeated contract.

Under the new agreement, Boeing has agreed to a re-study and minor variations in its system of performance analysis and relocation pay. These were the two main points of membership opposition. Under the company's performance analysis system, supervisors rate workers every six months. Boeing's policy of negotiating the relocation pay of employes sent to missile sites on an individual basis, rather than under uniform standards, had also caused complaints.

New Laser Materials Demonstrated

Two new semiconductor laser materials—indium-arsenide and indium phosphide—radiating at wavelengths of 3.1 microns and 0.903 microns respectively, have been demonstrated, the first by Massachusetts Institute of Technology's Lincoln Laboratory and the other by International Business Machines Corp.

Discovery of the two new materials, following by six months the announcement of first semiconductor laser using gallium arsenide by IBM and General Electric, confirms early hopes that gallium-arsenide was not a freak of nature. Unlike other types of lasers, the semiconductor type is extremely small, simple and requires no external flash tubes to serve as pumps, only a voltage impressed across the diode.

The discovery is important also because General Electric scientists have reported that indium-arsenide and gallium-arsenide, which radiates at 0.84 microns, can be mixed to provide a compound whose energy gap varies with the ratio of the two materials. This suggests that mixtures of the two can be tailored to produce almost any desired wavelength between 0.84 and 3.1 microns, according to a Lincoln Laboratory spokesman.

Lincoln Laboratory, whose scientists first achieved laser action with indium-arsenide, report that the wavelength of incoherent radiation from the material can be shifted to shorter wavelengths by subjecting the diode to a strong magnetic field, opening the way to magnetic tuning of laser radiation.

The IBM indium phosphide laser generates short pulses of coherent light when cooled to liquid nitrogen temperature (77K), but operates continuously at liquid helium temperature (4.2K). At 77K temperature, pulsed laser action occurs at a current threshold of 1½ amperes, equivalent to a current density of about 6,000 amperes per square centimeter, while at 4.2K the threshold current is 350 milliamperes. Above threshold, the line width of the emission narrows to less than two Angstroms at 77K and less than one Angstrom at 4.2K, IBM reports. The indium phosphide diode used is a zinc-doped N-type material with a junction area of 0.0002 to 0.0005 sq. cm.

The Lincoln Laboratory indium-arsenide diode, with a junction area of about 0.002 sq. cm., produced laser action at a current threshold of 10 amperes at 4.2K temperature and at 50 amperes at 77K when excited with 0.4 microsecond current pulses at a rate of 200 per sec.

Comsat Corp. Studies Planned

Washington—Communications Satellite Corp. will award study contracts in the near future to help determine what type of system should be established, Leo Welch, chairman of the corporation, and Joseph V. Charyk, president, told a House space subcommittee last week.

Value of each award will be in the area of $500,000 to $1 million.

The system will be random-orbit, low or medium altitude, with satellites generally patterned after the Telstar or Relay experimental projects. This is the type system that has been favored by National Aeronautics and Space Administration and Defense Dept. (AW Apr. 15, p. 27).

Under questioning, Charyk ruled out a high-altitude synchronous system for the private profit-making corporation until after booster technology for launchings is perfected by the federal government.

"Rather detailed studies will have to be made of the various technical approaches to a world-wide commercial communications satellite system," Charyk said. "In addition to evaluating the time schedules, technical risks and costs of various approaches, related economic analyses will have to be conducted to determine the specific course which will be most attractive from a combined technical and economic point of view. During this phase there will also have to be detailed discussions with other countries who may become participants in the ownership, operation and use of the total system. Understandings with such countries will at least have to be developed to the point where the extent of foreign financial participation is reasonably well defined, in order that the financial requirements of our own corporation can be developed in an adequate fashion" (AW Apr. 22, p. 74).

Welch estimated that stock would be floated in about 15 to 18 months. Half the stock will be offered to the public, and half reserved for communications common carriers. The maximum price established by law is $100 a share.

Welch told the subcommittee, headed by Rep. William Fitts Ryan (D.-N.Y.), that he thought a world system could commence functioning by 1967. "I say 'commence' because at the outset its coverage would probably not be global but would rather be limited to the more populous areas such as Europe, Japan, and possibly Latin America where traffic is expected to be sufficient to justify the construction of ground stations . . ," Welch said.

On the prospect for profits, Welch commented that "if a system can be established within a reasonable cost range, and if the satellites have the lifetimes predicted, a modest profit position can be attained sometime between 1969 and 1971 with the corporation at the same time fully discharging its huge responsibilities to the government and the public."

Comsat Terminal

Three aerospace companies have been selected by Army for program definition phase studies of the transportable satellite communications link terminal (TSCLT) to be used in conjunction with Defense Dept.'s medium altitude communication satellite.

The three firms are Hughes Aircraft, Radio Corp. of America and Sperry Rand Corp.

News Digest

General Electric has established an Advanced Engine and Technology Dept. under its Flight Propulsion Div. It will be headed by Fred O. MacFee Jr., and do work formerly done by the Flight Propulsion Laboratory Dept. which is being discontinued. David Cochran, former manager of the laboratory department, was named manager of nuclear space applications, reporting directly to Jack Parker, vice president of GE's aerospace and defense group. The lab department's nuclear materials and propulsion operation has been transferred to the company's advanced technology services.

Hercules Powder Co. will produce the propulsion system for the Army-Martin Nike X Sprint anti-missile missile system. Hercules program manager will be Richard Winer.

Brazil will study equatorial ionospheric characteristics by monitoring U. S. satellite transmissions at three sites straddling the equator under terms of a bilateral agreement signed by U. S. and Brazil. U. S. will launch Brazilian equipment to measure differential Doppler, group delay and Faraday rotation.

Twenty-seven Mirage 3C jet interceptors were shown for the first time in mass flybys at Haifa last week during Israel's Independence Day celebration. Israel is reported to have ordered 96 of the supersonic, delta wing jets.

State's International Air Role Increased

Department's aviation unit elevated in reorganization, will govern U. S. aviation dealings with other nations.

Washington—State Dept s plan to elevate the status of its aviation division will strengthen the U S position in international civil aviation negotiations with foreign nations, and could resnlt in a larger role for the State Dept in the establishment of rates and fares

The reorganization, scheduled to take effect next month, is expected to bring an end to the three-way conflict over international transportation jurisdiction that has involved State, the Civil Aeronautics Board and Federal Aviation Agency The change will definitely dwarf the FAA administrator's role as special adviser to the President on international aviation matters, and will re-fortify State Dept.'s role in the handling of bilateral agreements

CAB's 3-2 decision to reject the International Air Transport Assn fare boost on round-trip transatlantic tickets (AW Apr 29, p. 34) was a direct result of State Dept pressure, in compliance with the new policy on international aviation which, with few exceptions, State Dept has endorsed Under the reorganization, State Dept will have even a stronger say on such matters and could—through legislation—assume full authority over negotiations with foreign nations on international fares, although this is not currently contemplated

Allen Ferguson, of the Rand Corp., will head the new office, which will also handle such matters as communications, shipping and foreign trade The office will be directly under the assistant secretary of state for economic affairs, about two echelons above the position the current aviation division now holds Ferguson will report directly to Philip H. Trezise, deputy assistant secretary, who is now in Europe with CAB Chairman Alan S Boyd

Present office of transport and communications will be disbanded and its present chief, Edward A Bolster, who in the past has been handling bilateral negotiations, will be transferred to a post in Sydney, Australia The reorganization was undertaken as a result of an organizational study conducted by the Budget Bureau

The change coincides with a deadlock in the current U S fare dispute with European nations that may bring about some change in the IATA rate-making machinery There is only a slight chance that negotiations of international rates will be removed from the IATA traffic conference entirely and be taken over by governments, but there is every indication that governments will play a stronger role in the future establishment of tariffs.

State Dept is determined to keep international rates at the lowest possible level Boyd has agreed, on grounds that lower fares are a key factor in the new international policy The Board legally could have called a full summary hearing to determine whether or not foreign air carriers operating into the U S with higher fares would be contrary to the public interest, but since the policy calls for "persuasion" and not "coercion" in dealing with foreign nations, no such move was made.

Meanwhile, there were signs in London that the U S was capitulating under European pressure for the higher fares European carriers have decided formally to adopt the high fares May 12 in accordance with instructions from their governments

Late last month, Boyd offered a compromise that would permit reduction of the round trip discount, but would reduce one-way transatlantic fares by $10, minimizing the increase for the total round-trip fare The British government had not accepted the compromise proposal as of late last week, and gave every indication that it would expect both TWA and Pan American to charge the new rates beginning May 12 on flights into London

Although the first meeting of representatives of the U.S and other governments on the fare issue was unsuccessful, the 16 nations involved agreed to hold another conference, probably later this year, Boyd said They agree on the "need for closer and more frequent consultations between governments" as a means of resolving differences in international aviation

Thus it now seems certain that governments and their carriers will cooperate more closely in settling fare questions in advance of the IATA traffic conferences Boyd said he felt the London meeting was profitable, since the U S succeeded in clarifying for other governments the statutory requirements of CAB procedure

'We made it clear that the U S would not undertake any resentful or vituperative comments or acts if our carriers are forced into situations not to our liking," he said At present, neither the Board nor State Dept has authority to force U S carriers to retain the old fares, but legislation has been proposed to empower the Board to control international fares pertaining to passage to and from the U S

Meanwhile, Boyd and Trezise left London last week to present the new policy to the European governments They were to visit Paris and Rome last week, and Bonn, The Hague and Copenhagen this week The 600-page document they will use in explaining the new policy to the European governments has not been seen by U S carriers, although two airlines have already publicly given it their strong support

Last week, Sen Clifford Case (R N J) said he will reintroduce legislation calling for a Dept of Transportation in hopes of correcting some of the inequalities in the varying size of subsidies granted to the different modes of transportation

Before the reorganization of the State Dept transportation division was undertaken, strong consideration was given to placing the division head at a high diplomatic level. But it was felt that other industries with international interests would rightfully clamor for similar recognition

Aid Pact Withdrawal

New York—United Air Lines plans to pull out of the Mutual Aid Program under which carriers extend financial assistance to those grounded by strikes.

William A. Patterson, president of United, has said that he is tired of supporting other carriers for their inability to settle labor disputes such as those United has been able to resolve

To withdraw, Patterson would have to give notice by Nov. 1 of his intention to pull out effective Dec 31. The last day of the year is the specified withdrawal date for all carriers, and 60 days' notice is required

United has contributed approximately $6 million in strike aid through the program It was the largest supporter of Eastern Air Lines during that carrier's prolonged flight engineer strike.

Delta DC-9 Financing Plans

New York—Delta Air Lines will finance its order for 15 Douglas DC 9 short haul jet transports (AW Apr 29, p 33) on the basis of cash derived through depreciation accruals

The DC-9 order involves $55 million, including spares. Deliveries are to begin in 1966

Depreciation during 1964-66 will total $56 million and tax deferrals and net income will provide another $13 5 million over the same period if revenues meet expectations, according to Todd G Cole, Delta's executive vice president-administration. This will exceed by $46 5 million the required loan repayments of $23 million scheduled in the next three years

"Any additional financing necessary for the DC-9 program should therefore be readily arranged," he said

Cole said the DC-9 will be used primarily as a replacement for Delta's DC-6 and DC-7 aircraft

Seating will be 65 70 and the planes are being designed for two-man cockpit crews. However, space is allotted for a third crewman, who would be required if during design, the DC 9's gross weight grows from its present 77,500 lb to more than 80,000 lb

Delta sees a continuing need for its 21 Convair 440s. The carrier feels that the DC-9 and the British Aircraft Corp BAC 111, with their seating capacity and less-spares cost of $3 million each, are too large for Delta's short feeder routes, he said

Transition to the short-haul jet will be more orderly than it was for the first family of jets, Cole said

Cash generated prior to 1966 will ease the financing impact. The short-haul jet will not be a prime competitor in major markets and thus will not provide the airlines with incentive to place a large number in service in a short time, Cole said.

The seating capacity will not be significantly greater—and in some cases will be less—than the equipment it will replace, he added

Delta April Traffic Increases 25%; General Gain Seen for Carriers

By James R. Ashlock

New York—April traffic for Delta Air Lines increased 25% over last year—exceeding the carrier's forecast for the month—and an informal poll by Delta of other airlines indicates an over-all 10-12% rise in passenger volumes

"It's too early to be sure this is a definite upward trend," Todd G Cole, Delta's executive vice president administration, told the New York Society of Security Analysts last week

"We had the benefit of the Easter holiday traffic, but we had Easter last year in April, too," he said "The general psychology of the country is better today Although some segments of the economy are draggy the general economy continues to do better and will probably keep on doing so, particularly with federal spending remaining at high levels"

Though Cole indicated prospects appear better for the airlines, he added, "six months from now could prove me wrong"

Cole said he felt, however, that the general financial status of the trunkline industry was good, and he criticized the insistence of some carriers that a depressed condition exists which necessitates mergers.

"The trunkline industry is on firmer financial ground now than at any time since the initial commitments for jets," Cole said.

In 1962, operating profit for the 11 domestic trunklines was $116 million Cole said, five times the operating profit realized in 1961

"The system net profit for the 11 trunklines in 1962 was $28,693,000 after interest, taxes and all other charges as compared with a net loss of $37,700,000 in 1961—an improvement of $66.4 million."

"The system return on investment for the 11 carriers exceeded 5% in 1962—admittedly only half of the rate established by the Civil Aeronautics Board as fair and reasonable but far above the level that the prophets of doom would have you believe prevails," he said

Cole said his figures are higher than those reported by the carriers to the CAB Eight of the 11 airlines, he said, have operations outside of the U S, but these eight report only the results of domestic performance While only $76 million in operating profits was reported on domestic services, another $40 million was realized on international and territorial routes The $116 million operating profit is the true figure in which stockholders and investors are interested, Cole said.

"The aggregate profit was $137 million for the nine trunklines excluding Eastern and Northeast, the only two reporting system operating losses in 1962,' Cole said "This doesn't sound like an industry on the brink of financial disaster"

Cole blamed American Airlines and Eastern Air Lines for fostering the air of depression in an attempt to justify their proposed merger

Cole expressed no sympathy for Eastern's claim that its financial troubles stem from the excessive competition to which it has been exposed in recent years

"It is incredible that anyone intimately familiar with our industry could suggest that Eastern's routes cannot be operated successfully," he said "That basic route system proved the most profitable in the country for almost a quarter century."

Delta's analysis of Eastern's operation as outlined by Cole indicates that Eastern's difficulty is due not to competition, but to that carrier's failure to attract a pro rata share of the available traffic.

In the first half of 1962, Cole said Eastern earned only 30% of the traffic between Cincinnati and Miami, leaving 70% to Delta In the two-carrier Minneapolis-Miami and Minneapolis-Tampa markets, into which Eastern was placed in 1958 to provide competitive service, Eastern's share was less than 20%.

These figures are adjusted to consider the Eastern strike which extended through seven of the 181 days in the period, Cole said

He said Eastern itself is accountable for many of the burdens placed on the route system where it claims competition is excessive These burdens were identified as Eastern's heavy scheduling, its reliance on turboprop aircraft, delays in acquiring jets and recurring labor disputes

'No more eloquent testimony of the intrinsic strength of these routes can be found than in their ability to not only withstand these burdens but to once again produce traffic at record levels—as they are doing this month now that the burdensome problems cited above are largely of historical interest only," he said

In contradiction of American's and Eastern's claims Cole said things are improving for the domestic trunkline industry Break-even load factors for jets have dropped from 58 28% in 1960 to 51 27% in 1962, and the gap between capacity and demand is taper-

ing with the slowdown in jet acquisitions.

"If the economy of the nation remains strong and healthy, growth in air line traffic of 8-10% a year can reasonably be expected," he said.

The picture is even brighter in respect to cash flow, the factor in which investors are particularly interested, Cole said. In 1962, cash generated by the trunklines reached a record $368 million, bringing to $882 million the total cash generated in the three "difficult" years of 1960, 1961 and 1962.

"Even Eastern's reported losses of $26.5 million during these three years were recorded after depreciation and obsolescence accruals of $124 million in just these 36 months," he said.

Industry's major problem, as seen by Cole, is the continuing decline in yield on fares, an element he blames on diversion from first class to coach and the widespread introduction of low promotional fares. This is evidenced, he said, by Delta's gaining only 14% in revenues during the last January-March quarter, while revenue passenger miles flown rose 16%.

"As a result of the erosion in yields, the average passenger-mile yield today on the domestic trunkline services is less than 5% above 1950—a period in which the cost-of-living index rose 25%."

For a while after coach class was introduced in the piston era, Cole said, it accounted for only 30% of the total airline traffic. Today it accounts for 65%. The 25% difference between coach and first-class fares is too great, he believes. In the piston era, a 25% discount was a realistic figure for the difference between first-class and tourist service, Cole said, but the same is not true of jet aircraft.

"If there were a 50-50 division between first-class and coach capacity and the price difference were only 12.5%, the trunklines in 1962 would have gained $200 million in additional revenues," he estimated.

Cole said the single fare experiment by United Air Lines is perhaps good to the extent that it could bring order out of chaos. However, he feels that the fare is weighted so that it is closer to first class fares on shorter segments and thus may be a prelude to United's introduction of single class and perhaps all first class on its Boeing 727s.

"If the airlines ever did agree on a single fare," Cole said, "some fear that the special fare cycle would start all over again. In this country, there will always be people who are willing to pay for a better class of service."

Cole said Delta is having "an excellent year." Net earnings for the first nine months of the current fiscal year were $10,205,000, equivalent to $4 a share on 2,550,000 shares outstanding. This compares with $3,754,000 net earnings in the same period a year ago.

Earnings for the January-March, 1963, quarter were $2,471,000, and April yielded an unexpected continuance of the upward trend, with Delta's passenger volume rising 25% for the month, bringing a 17% increase in revenues.

"If earnings from operations in the June quarter are the same as they were a year ago," Cole said, "earnings for the 1963 fiscal year will be $12,625,000 or $4.95 a share."

Cole said Delta's only outstanding near-term commitments involve the delivery of two Douglas DC-8 fan jets in November and December and the installation of turbofans on the six DC-8s acquired in 1959.

Payments of $22 million still due on these two programs will be made from $8 million yet to be drawn on a 1961 bank credit agreement and from internally generated cash, he said.

Cole said that 82% of Delta's revenues come from points served by two or more competitive carriers. So far in 1963, its two-year-old southern transcontinental service is accounting for 30% of the increase in passenger volumes.

Interchange Proposal

New York—Interchange agreement which would generate a Pan American World Airways DC-8 flight between New Orleans, Atlanta and the East Coast was filed with the Civil Aeronautics Board last week by Pan American and Delta Air Lines.

Service, which would provide the first daily single-plane transatlantic schedules from New Orleans and Atlanta, would begin late this summer. The East Coast gateway would be determined later. It would be either Dulles, Philadelphia, Baltimore or Idlewild.

Delta crews would fly the aircraft on domestic segments, with Pan American crews taking it on to London three or four days each week, and to Paris other days.

Arrangements would be similar to that now operated by Pan American and Braniff Airways, which provides service from Houston and Dallas to Europe via Chicago.

Braniff Seeks Panagra Stock Purchase

Dallas—Braniff Airways' board of directors last week authorized the carrier to offer $22 million for purchase of Panagra from Pan American World Airways and W. R. Grace, each of whom owns 50% of Panagra's shares.

Braniff's offer to each of Panagra's owners to purchase their entire holdings is somewhat above the $10,625,000 that Pan American and W. R. Grace agreed upon as a result of a recent offer by PAA to buy out W. R. Grace (AW Apr. 29, p. 37). Braniff says it considers the additional money "practical recognition" of the fact that the Pan Am-Grace agreement permits Grace to accept shares in PAA which might net the seller something more than the sale price.

Simultaneously with advising the Civil Aeronautics Board of its intent to make the offer to Pan American and Grace, Braniff filed notice with CAB of its intention to oppose the purchase by Pan American of Grace's 50% ownership. Braniff President Charles E. Beard commented that 100% ownership of Panagra by Pan American would in effect thwart CAB's efforts in past years to create truly competitive U.S. flag service between the U.S. and South America.

Braniff, filing with the CAB, requested the Board to establish a limited route proceeding and consolidate in it the public interest aspects of Pan American's and Grace's joint ownership of Panagra and Pan American's application to acquire Grace's share of Panagra.

Braniff stated that this procedure would enable CAB to finally resolve in one special proceeding the question of U.S. competitive service to South America.

Civil Aeronautics Board in 1961 initiated a proceeding, the United States-South America route case, which has not yet been brought to a hearing. It contains a proposal that South America be served by two carriers instead of the current three, Pan American, Panagra and Braniff.

Hughes Judgment

New York—Default judgment was entered against the Hughes Tool Co. late last week by the U.S. District Court on the basis of Howard Hughes' failure to appear to TWA's $115 million anti-trust litigation against the Hughes Tool Co. (AW Feb. 18, p. 49). Attorneys for Hughes plan to appeal.

Judge Charles Metzner of the U.S. District Court here said he also would initiate an order dismissing Hughes' $385 million counterclaim against TWA. He charged the special master, J. L. Rankin, with scheduling hearings to determine the amount of damages due TWA.

Metzner said he would determine at a later date whether or not Hughes must divest himself of his 78.2% controlling interest in TWA, which was requested in TWA's suit.

Southern Route Thrives on Space Industry

By L. L. Doty

Los Angeles—Booming aerospace and electronic industries, backbone of the new southern transcontinental route, are attracting intense airline interest that could bring about a drastic reshaping of U. S. air route structures during the next decade.

A 6,500-mi., two-week survey of the busy route by AVIATION WEEK & SPACE TECHNOLOGY indicates the new route is emerging rapidly as the nation's newest major air travel market. It covers an area through the south from Florida to California where the first significant break away from the traditional U. S. trading centers is being made.

Both National Airlines and Delta Air Lines, which are certificated to serve the route coast-to-coast, will have completed two full years of scheduled operations over the route next month. The route has injected new life into National and substantially bolstered Delta's income, although the latter still derives 80% of its revenues from the older north-south and southeastern routes.

All 11 trunklines penetrate the route at one point or another from Miami to Los Angeles and San Francisco. Routes of four carriers—American Airlines, Braniff Airways, Continental Air Lines and Eastern Air Lines—parallel the route over certain segments and these carriers have benefitted directly from this expanding market. Virtually the entire airline industry is pointing sales campaigns to the south.

Route Structures

A clue to the industry's thinking on this market's future came from a United Air Lines representative who said that with the decentralization of the aerospace industry and its growth throughout the south airline route structures will become outmoded unless they are adjusted to this change. TWA is also taking a broad look at the space market. Braniff, frustrated in its bid for a southern route to Florida, appealed to a civil court after Civil Aeronautics Board rejected its petition for a Dallas-Miami route. The court remanded the case to the Board, which upheld its original findings.

The aerospace industry was not considered a factor in the CAB Southern Transcontinental Route Case that resulted in the awards to National and Delta, and as a result, traffic volume has surpassed the growth estimates used by the Board in making the decision. Although Delta still contends that the route was overcertificated in that decision, the emergence of new traffic markets is forcing transformations in the route pattern that portend further revisions in the future.

First change in the route structure occurred with the inauguration of a route by National from Melbourne, Fla.—unmentioned in the route case—to New Orleans, Houston and the West Coast to handle traffic generated by Cape Canaveral. Orlando, claiming to be the historic gateway to the Cape, is striving to prevent any diversion of traffic from its airport to Melbourne, an indication of the importance now being placed on the new route.

In addition, National has found greater value in serving the route's major intermediate points rather than in operating non-stop coast-to-coast. A further sign of transition is the traffic moving to and from Houston, where several years ago, close to 40% of the airline business was related to petroleum and affiliated industries. Today, traffic associated with the space industry is accounting for a steadily increasing share of airline business at Houston, due to the Manned Spacecraft Center under construction there by the National Aeronautics and Space Administration.

Last week, a CAB examiner recommended that Huntsville be added to Delta's Atlanta-California route.

Airports along the route are competing to establish themselves as international air traffic hubs with modern terminals, runways and facilities. Miami, for example, is served by 11 U. S. certificated scheduled carriers, 19 foreign flag airlines, 56 irregular carriers and innumerable air taxi operators. Los Angeles with a new complex of satellite terminals appears to be pulling ahead of San Francisco as California's major international port.

Houston is constructing new airport facilities, and the terminals at Atlanta, New Orleans and Dallas are new. CAB hearings on the Dallas-Ft. Worth regional airport investigation are scheduled to begin July 8, but currently Dallas' Love Field is busier than Ft. Worth's Amon Carter Field. Five of the airports on the southern transcontinental route ranked among the nation's 10 busiest airports in 1962.

Airlines serving the route and its segments are not overlooking the tourist travel potential. Las Vegas, Nev., a city of 65,000 people, is served daily by more than 100 scheduled airline flights, carrying mostly tourists. San Diego, where industrial activity has leveled off in recent years, now considers tourism a major source of business.

J. Dan Broek, National's vice president of traffic and sales, sees a growing community of interest between California and Florida, historic rivals for winter season tourist trade. Brock believes that Californians, unlike Easterners, are highly flexible in their vacation travel habits and can be persuaded to explore the Caribbean tourist areas or use the Miami gateway for European travel.

All smaller trunklines serving all or portions of the route are highly optimistic over financial prospects for 1963 as a result of the new market's traffic growth. Equally significant in an analysis of the earning levels of the smaller carriers—Braniff, Continental, Delta, National and Western—are the tight economic and sound financial bases on which they operate.

Braniff's recent refinancing program is a case in point, illustrating the financial community's reaction to these operating standards. The airline itself financed its initial order for six BAC 111 turbofan transports but it needed an additional $20 million in long-term borrowing to take its option on an additional six.

Differing Philosophies

Its first bid for new funds earlier this year resulted in offers of loans totalling $37 million—$17 million more than it required—on highly favorable terms, despite general pessimism about the airline industry's profit potential among major lenders.

Operating philosophies of the four airlines differ in many respects, so that any comparison of each carrier's approach to the new route and the new sources of business would be unrealistic, but there are certain similarities in the broad economic outlook of each.

C. E. Woolman, veteran president of Delta, and L. B. Maytag, Jr., new president of National, have never met, but each has a high respect for the other as principal competitors on the new route. Both men thrive on financial stability, which has been attained by Delta through historic frugality and by National through a revamped fiscal program undertaken last year when Maytag took over the presidency from G. T. Baker.

Both Woolman and Maytag are vigorous opponents of the proposed American-Eastern merger, and Woolman has consistently led industry attacks on the plan. Of the five carriers, only Western has taken no stand on the issue. Its president, T. C. Drink water, who is not interested in talking merger with anyone, feels that a combined American-Eastern company would have no competitive effect on Western.

Braniff President Charles E. Beard is a belligerent foe of the merger and points out that the merged company would have total assets one and one-half times the combined assets of Braniff, Continental, Delta, National, Western and Northwest Airlines.

Delta has been an outspoken critic of alleged attempts by American to portray a poor financial condition and has challenged openly its financial reporting. Meanwhile, many airline officials throughout the south are watching the apparent decline in Eastern's aggressive sales practices, particularly on those routes where Eastern always held a strong position.

Carriers competing directly with Eastern admit that their success in 1962 was attributable largely to the Eastern flight engineers' strike. But they add that the carrier's slow recovery from the effect of the strike is expanding these benefits.

Throughout the survey, there were expressions that the decline in Eastern's competitive drive is a part of an overall merger strategy. It should be noted that Eastern's recently introduced Walk-On service between New Orleans and Houston is undoubtedly a competitive stroke at the southern transcontinental services. But several airline officials question the economic effectiveness of the operation, and one termed it an isolated move, too small to stem the flood of Eastern's difficulties.

Generally, all carriers deplore the present multitude of tariff structures, but only Maytag has gone so far as to endorse United's single-fare concept. Delta feels that the aircraft seating configuration called for under the single-fare plan cannot be applied practically to a mixed fleet of piston and jet aircraft or jets of long and short range.

Fare Structures

Braniff will watch United's experiment "closely," but would be more interested were the rate level higher—perhaps midway between present first-class and coach rates, or about 12½% above coach. United single-class fare has been set about 4% higher than the current coach rate. Beard, like W. A. Patterson, president of United, has persistently sought a narrower gap between coach and first-class fares.

Western is focusing its attention on coach traffic, and expects that this class soon will account for about 90% of all its traffic. In March, Western led the industry with a 23% traffic increase and a 54% increase in coach revenue passenger miles.

Both Delta and National are experiencing the current switch from first-class to coach traffic. An interesting surplus item in Delta's inventory of parts is a large stack of first-class seats—a situation that undoubtedly exists throughout the industry.

Delta experienced a 14% decrease in first-class traffic in March and a 36% increase in coach traffic. National's first-class traffic in the same month dropped 12% and coach traffic rose 31%. Biggest gains in coach traffic were registered by Continental, with 63%, and a 21% increase in all traffic.

Braniff finds a continuing demand for first-class transportation, which it attributes to the carrier's very short-haul routes where the slight savings in fare do not justify passengers denying themselves the conveniences of first-class service. In March, Braniff's coach traffic accounted for 59% of all its traffic.

On the subject of aircraft equipment, National has no immediate plans for fleet expansion. It is satisfied that the Lockheed Electra turboprop transport, which is being utilized at a direct operating cost of $1.33 per mile, will continue to serve short-haul routes during the foreseeable future. The airline will switch to short-range jets only if competitive conditions require such a move. Beyond that possibility, National's fleet expansion, when it does occur, will be confined to additional Douglas DC-8 turbofan transports.

Equipment Needs

Delta has placed a $50 million order for 15 Douglas DC-9 short-haul transports for use on its shorter haul routes where traffic volume justifies jet service. Braniff sees a need for the short-haul jet as demonstrated by its purchase of 12 BAC 111s, but it will continue using the Lockheed Electra, which it also finds to be an outstandingly efficient and serviceable airplane.

Western will decide this summer on whether it will buy the DC-9 or BAC 111. Continental plans to add a short haul jet to its fleet, probably in 1965.

Braniff anticipates a loss for the first quarter of 1963, but expects to end the year with record profits. Western has reported record first-quarter earnings of $1.7 million. For the first nine months of its fiscal year, which ends June 30, National reported net earnings of $5.3 million. Delta's net earnings for the first nine months of its current fiscal year were $10 million.

On the transcontinental route, National is keying its flight schedules to aircraft utilization. Delta's schedules are planned on the traffic potential indicated in the various markets it serves with less emphasis on utilization.

National has a 10 hr. 30 min. utilization on its Douglas DC-8 fleet, and predicts this will climb to 11 hr. 6 min. this summer. For the first eight months of its fiscal year, the break-even load factor was 46%, compared with 52% in the same period last year. System load factor for the current eight months was 54%, about the same as in the previous eight-month period.

National believes the southern transcontinental route is a major factor in its profit position, and stresses that its profit margin is being depressed by the heavy competition it faces on the New York-Florida route, a condition it terms "unhealthy." Maytag responded to a recent CAB examiner's decision that this route needs three carriers by noting that the "markets have failed to support the systems of three carriers in the past." He added "there is no reasonable likelihood that they will be in the future."

Financial Positions

Delta, on the other hand, finds that about 20% of its over-all revenues come from the southern transcontinental route. In March, Delta's load factor on the route was 52.2%, compared with its system load factor of 59.9%. As of mid-April, load factor of the transcontinental route stood at 56.3% and the airline's system load factor had climbed to 63%.

National has strengthened its financial position since the new management took over last year and in February, had a working capital of $12 million, of which $7.5 million is represented by the Pan American stock trade agreement made with that airline during the Baker regime. In June, 1962, working capital was $1.5 million and, since the Pan American stock represented some $8.1 million, the carrier had, at that time, a working capital deficit of about $6.6 million.

For the first eight months of Fiscal 1963, seat mile costs have been cut to 2.97 cents, compared with 3.15 in the same period of Fiscal 1962. The airline is predicting an income of more than $3 per share at the end of Fiscal 1963.

National has traded back 10% of its Pan American stock holdings with Pan American, but has no immediate plans for further disposal of the stock. Under the CAB ruling governing the transaction, the airlines have until July, 1964, to complete disposal of their respective holdings.

To refinance its outstanding debts and cover equipment purchase commitments, National arranged a new loan agreement for $51 million which permitted it to retire $29.2 million remaining from a 1958 bank loan, $4.5 million of a 1960 demand note, $4.6 million owed to Douglas Aircraft Co., and $12.7 million to finance the purchase of three Douglas DC-8 turbofan transports.

Increases In Airline Operating Revenues

(In Thousands of Dollars)	PASSENGER REVENUE			TOTAL OPERATING REVENUE			NET PROFIT (OR LOSS)		
	1961	1962	Increase	1961	1962	% Incr.	1961	1962	Increase
DOMESTIC TRUNKS									
American	367,829	402,829	35,000	414,832	452,428	9.1	7,449	8,447	998
Braniff	70,209	75,905	5,696	77,605	84,558	9.0	1,968	3,787	1,819
Continental	58,233	60,658	2,425	62,996	66,238	5.1	1,121	1,779	658
Delta	143,385	178,342	34,957	155,252	195,694	26.0	5,512	13,462	7,950
Eastern	242,027	223,455	(18,572)	261,989	256,667	(2.0)	(10,067)	(14,425)	(4,358)
National	66,549	91,415	24,866	74,515	102,139	37.1	(2,358)	7,498	9,856
Northeast[1]	48,012	48,606	594	51,729	51,891	1.6	(9,442)	(7,379)	2,063
Northwest	62,235	90,466	28,231	71,984	100,568	39.7	83	2,631	2,548
Trans-World	250,296	270,814	20,518	279,648	298,753	6.8	(24,995)	(12,499)	12,496
United	463,211	505,182	41,971	517,277	563,336	8.9	(4,492)	3,348	7,840
Western	54,835	73,828	18,993	59,141	78,769	33.2	655	3,729	3,074
Trunk Total	1,826,821	2,021,500	194,679	2,026,368	2,251,841	11.1	(34,566)	10,378	44,944
INTERNATIONAL									
American	5,377	7,482	2,105	6,533	8,521	30.4	(171)	1,080	1,251
Braniff	9,151	8,119	(1,032)	11,792	9,895	(16.1)	(693)	(1,358)	(665)
Caribair	3,634	4,737	1,103	4,008	5,190	29.5	270	126	(144)
Delta	1,515	2,220	705	1,652	2,420	46.5	(590)	(328)	262
Eastern	30,949	26,613	(4,336)	33,391	31,445	(5.8)	459	1,076	617
Mackey	1,693	1,519	(174)	1,911	1,864	(2.5)	(130)	11	141
Northwest	23,736	31,316	7,580	29,128	29,902	27.5	3,578	4,599	1,021
Panagra	16,112	15,591	(521)	22,821	22,381	(1.9)	161	926	765
Pan American	333,842	365,129	31,287	458,054	501,693	9.5	7,268	15,007	7,739
South Pacific	615	373	(242)	640	463	(27.7)	(721)	(851)	(130)
Trans-Caribbean	4,477	7,039	2,562	5,978	9,761	63.3	(510)	150	660
Trans-World	61,862	76,977	15,115	83,270	102,118	22.6	(13,710)	6,812	20,522
United	24,560	27,791	3,231	27,020	30,917	14.4	2,990	4,382	1,392
Western	4,902	7,342	2,440	5,111	7,601	48.7	209	1,285	1,076
International Total	522,425	582,248	59,823	781,378	784,171	11.8	(1,598)	32,917	34,587
LOCAL SERVICE									
Allegheny	12,932	15,518	2,586	20,500	23,540	14.8	(24)	661	685
Bonanza	5,699	7,441	1,742	9,252	11,018	19.1	456	607	151
Central	3,695	5,219	1,524	8,070	10,494	30.0	101	242	141
Frontier	7,234	7,865	631	14,886	15,948	7.1	308	575	267
Lake Central	5,267	5,793	526	9,742	10,778	10.6	(61)	176	237
Mohawk	12,666	16,998	4,332	18,310	23,344	27.5	330	541	211
North Central	15,632	16,799	1,167	25,194	27,125	7.7	1,855	407	(1,448)
Ozark	8,075	9,454	1,379	13,264	15,082	13.7	339	353	14
Pacific	6,389	7,426	1,037	11,095	12,077	8.9	317	170	(147)
Piedmont	8,386	12,139	3,753	13,712	18,133	32.2	473	1,160	687
Southern	5,669	7,720	2,051	10,697	14,057	31.4	204	305	101
Trans-Texas	5,331	6,445	1,114	10,001	12,011	20.1	67	259	192
West Coast	6,647	6,648	1	12,333	12,492	1.3	469	464	(5)
Local Service Total	103,622	125,465	21,843	177,856	206,099	16.4	4,834	5,920	1,086
ALASKA & HAWAIIAN									
Alaska Airlines	2,972	3,917	945	8,720	9,963	14.3	(312)	(883)	(571)
A. Coastal/Ellis	1,662	1,765	103	3,381	3,445	1.9	(40)	(112)	(72)
Aloha	4,895	5,191	296	5,540	5,717	3.2	(154)	134	288
Cordova	221	281	60	1,310	1,336	2.0	(39)	(15)	24
Hawaiian	6,747	6,632	(115)	8,546	7,963	(6.8)	287	(153)	(440)
Kodiak[1]	197	236	39	349	435	24.6	(9)	46	55
Nu Coastal/Ellis	1,116	1,034	(82)	4,367	3,855	(11.7)	311	208	(103)
Pacific Northern	7,705	8,667	962	12,322	13,286	7.8	262	(338)	(600)
Reeve Aleutian	1,663	1,575	(88)	3,070	3,179	3.6	401	319	(82)
Western Alaska	88	73	(15)	348	339	(2.6)	25	(15)	(40)
Wien Alaska	1,234	1,372	138	6,042	6,122	1.3	273	111	(162)
Alas. & Hawaiian Total	28,500	30,743	2,243	53,995	55,640	3.0	1,005	(698)	(1,703)
HELICOPTERS									
Chicago	1,423	526	(897)	3,352	2,046	(39.0)	149	115	(34)
Los Angeles[1]	248	370	122	1,651	2,281	38.2	47	70	23
New York	1,102	1,499	397	3,600	3,910	8.6	(242)	(116)	126
Helicopter Total	2,773	2,395	(378)	8,603	8,237	(4.3)	(46)	69	115
CARGO & OTHERS									
AAXICO				4,488	7,362	89.4	(150)	543	693
Aerovias				2,471	1,747	(29.3)	(218)	(296)	(78)
Avalon	450	383	(67)	515	610	18.4	(75)	46	121
Flying Tiger				32,427	52,263	61.2	(3,721)	2,811	6,532
Riddle				23,706	23,898	0.8	(133)	(865)	(732)
Seaboard				20,594	23,104	12.2	(3,778)	1,017	4,795
Slick				11,992	21,769	81.5	1,103	1,262	159
Total Cargo & Other	450	383	(67)	96,187	130,995	38.2	(6,972)	4,578	11,498
Industry Total	2,484,591	2,762,734	278,143	3,063,579	3,436,183	12.2	(37,335)	53,184	90,439

[1] 1962 data is for year ending Sept. 30th. [2] 1962 data is preliminary.

Prepared by Roy & Ray

U.S. Airline Operating Revenues and Expenses—1962

(In Thousands of Dollars)	OPERATING REVENUES								
	Passenger	U.S. Mail	Foreign Mail	Cargo	Charter	Other Transport	Incidental	Federal Subsidy	Total
DOMESTIC TRUNKS									
American	402,829	10,706		38,750	1,827	691	12,375]		452,426
Braniff	75,905	2,306		5,133	862	135	215		84,558
Continental	60,658	1,442		3,190	555	164	229		66,238
Delta	178,342	4,273		11,588	868	148	475		195,694
Eastern	223,455	4,831		11,748	234	553	15,846		256,667
National	91,415	1,974		7,035	1,068	212	435		102,139
Northeast [1]	48,606	739		2,044	67	144	291		51,891
Northwest	90,466	2,813		7,178	269	174	(332)		100,568
Trans-World	270,814	6,833		16,029	2,132	645	295		298,753
United	305,182	17,254		37,735	4,375	997	(2,207)		363,336
Western	73,828	1,355		2,804	342	142	298		78,769
Trunk Total	2,821,300	54,328		145,234	12,604	4,095	13,170		2,251,041
INTERNATIONAL									
American	7,482	35	[illegible]	629	45	[illegible]	[illegible]		8,111
Braniff	8,119	381	180	1,210	7	14	116)		9,895
Caribair	4,737	42	1	310	42		58		5,190
Delta	2,220	5	5	188		?	1		2,420
Eastern	26,613	587	12	1,651	11		2,571		31,445
Mackey	1,519			76	226	5	36		1,864
Northwest	31,316	10,091	1,324	4,650	2,201	2	318		49,902
Panagra	15,591	759	727	3,690	60	6	1,528		22,381
Pan American	365,129	38,578	5,796	56,005	34,672	869	644		501,693
South Pacific	373	11	2	11	70		14)		463
Trans-Caribbean [1]	7,039		4	570	1,638	9	501		9,761
Trans-World	76,977	13,152	1,215	8,861	539	75	1,299		102,118
United	27,791	1,439		1,184	51	7	445		30,917
Western	7,342	45	27	160			27		7,601
International Total	582,248	65,123	9,361	79,214	39,585	988	7,652		784,171
LOCAL SERVICE									
Allegheny	15,518	316		1,043	91	29	53	6,490	23,540
Bonanza	7,441	49		222	3	31	63	3,209	11,018
Central	5,219	196		365	63	14	48	4,589	10,494
Frontier	7,865	187		539	52	8	92	7,205	15,948
Lake Central	5,793	153		433	145	7	52	4,195	10,778
Mohawk [2]	16,998	264		698	386	104	262	4,632	23,344
North Central	16,799	465		1,085	131	48	70	8,527	27,125
Ozark	9,454	216		646	11	16	73	4,666	15,082
Pacific	7,426	178		275	25	16	24	4,133	12,077
Piedmont	12,139	239		575	118	6	218	4,838	18,133
Southern	7,720	278		434	204	9	36	5,376	14,057
Trans-Texas	6,445	196		417	107	14	63	4,769	12,011
West Coast	6,648	124		258	78	25	38	5,321	12,492
Local Service Total	125,465	2,861		6,999	1,414	327	1,092	67,950	206,099
ALASKA & HAWAIIAN									
Alaska Airlines [1]	3,917	365		579	2,805	15	252	2,012	9,945
A. Coastal/Ellis	1,765	179		233	56		69	1,143	3,445
Alaska	5,191	29		106	1	8	225	157	5,717
Cordova	281	108		163	295	2	24	463	1,336
Hawaiian	6,632	49		1,166	11	6	26	73	7,963
Kodiak [1]	236	11		35	97		2	54	435
Ne. Consolidated	1,034	878		488	126	3	48	1,278	3,855
Pacific Northern	8,667	1,232		1,783	50	23	116	1,415	13,286
Seave Aleutian	1,575	662		419	377		146		3,179
Western Alaska	73	21		14	59	1	6	165	339
Wien Alaska	1,372	1,015		557	1,075	2	72	2,029	6,122
Alaska & Hawaiian Total	30,743	4,709		5,541	4,752	60	986	8,789	55,648
HELICOPTERS									
Chicago	526	23		70	4	1	4	1,478	2,044
Los Angeles [1]	370	143		184	2	2	1	1,579	2,281
New York	1,499	16		65	104		10	2,216	3,910
Helicopter Total	2,395	182		259	116	3	15	5,273	8,237
CARGO & OTHER									
AAXICO					2,455		154		2,609
Aeravias				573	1,128		48		1,749
Avalon	383	16		7	202	1	1		610
Flying Tiger		60		10,237	41,793	19	154		52,263
Riddle		88		2,003	21,717		90		23,898
Seaboard		4,116	163	10,082	8,517	36	190		23,104
Slick		8		639	21,050		72		21,769
Total Cargo & Other	383	4,288	163	23,541	101,858	56	714		130,995
Industry Total	2,762,734	131,751	9,524	260,778	160,315	5,439	23,629	82,812	3,436,183

[1] Data is for year ending Sept. 30, 1962. [2] Preliminary report.

Prepared by Bay & Bay

(In Thousands of Dollars)	OPERATING EXPENSES								Net Profit (or Loss)
	Flying Operations	Maintenance	Passenger Service	Aircraft & Traffic Service	Promotion & Sales	General & Admin.	Deprec. & Amort.	Total	
DOMESTIC TRUNKS									
American	101,874	105,264	32,694	74,700	47,942	19,114	51,506	433,094	8,447
Braniff	22,012	16,495	6,451	14,525	8,532	3,011	6,616	77,644	3,787
Continental	17,308	11,098	5,479	8,087	6,304	3,080	9,892	61,248	1,779
Delta	45,660	34,673	13,545	27,432	20,159	4,839	18,775	165,083	13,462
Eastern	84,327	48,254	19,005	39,869	30,868	11,235	41,735	275,293	114,4251
National	26,525	16,829	6,785	13,349	11,961	2,700	9,985	88,134	7,498
Northeast [1]	19,250	13,455	3,969	9,483	6,831	1,675	4,314	58,977	(7,379)
Northwest	28,079	17,403	7,246	12,137	8,642	5,391	13,516	92,414	2,631
Trans-World	82,417	62,122	22,951	47,754	34,710	11,664	44,525	306,143	112,499)
United	148,007	106,742	41,610	105,402	56,871	22,868	66,990	548,490	3,348
Western	19,003	11,710	5,007	10,235	9,500	3,516	11,208	70,179	3,729
Trunk Total	594,462	444,045	164,742	362,973	242,320	89,093	279,064	2,176,699	18,378
INTERNATIONAL									
American	1,531	1,154	602	1,147	847	396	865	6,542	1,080
Braniff	3,301	1,898	967	2,130	1,893	858	1,425	12,492	(1,358)
Caribair	1,165	759				2,534	421	4,919	126
Delta	889	640	172	410	493	97	368	3,069	(328)
Eastern	10,198	5,157	1,953	4,285	2,194	1,086	4,197	29,070	1,076
Mackey	637	288				857	175	1,957	11
Northwest	10,868	5,841	2,340	5,162	6,388	3,305	4,930	38,834	4,599
Panagra	4,582	3,961	1,502	2,729	3,906	1,613	2,371	20,664	926
Pan American	120,329	72,595	37,231	74,726	74,488	21,184	58,346	458,899	15,007
South Pacific	306	171				648	78	1,203	(851)
Trans-Caribbean [1]	2,219	1,616	607	1,182	1,391	774	1,040	8,829	150
Trans-World	21,025	11,388	6,896	12,508	16,748	4,406	11,877	86,848	6,812
United	6,335	3,120	1,684	2,381	3,784	1,332	2,546	21,182	4,382
Western	1,310	736	510	626	694	247	687	4,810	1,265
International Total	184,695	109,364	54,484	107,286	114,826	39,337	89,326	699,318	32,917
LOCAL SERVICE									
Allegheny	6,333	4,544	1,048	5,062	2,089	1,219	1,549	21,782	881
Bonanza	2,342	1,799	451	1,931	1,204	836	876	9,439	607
Central	2,973	2,041	501	2,913	765	561	287	10,041	242
Frontier	4,712	3,183	799	3,823	939	954	737	15,147	575
Lake Central	3,077	1,923	604	2,750	833	602	633	10,422	176
Mohawk [2]	5,567	5,277	969	4,989	2,618	1,139	1,461	22,020	541
North Central	7,198	5,675	1,303	7,275	1,968	1,044	1,191	25,634	407
Ozark	4,202	3,214	765	3,990	890	785	463	14,309	353
Pacific	3,111	2,665	443	2,218	1,234	835	828	11,334	170
Piedmont	4,961	3,857	793	4,359	1,104	643	1,058	16,775	1,160
Southern	3,772	2,961	716	3,478	869	695	557	13,078	305
Trans-Texas	3,361	3,033	687	2,692	814	673	322	11,582	259
West Coast	3,472	2,116	648	2,614	962	726	646	11,184	464
Local Service Total	55,081	42,308	9,727	48,094	16,299	10,610	10,668	192,727	5,920
ALASKA & HAWAIIAN									
Alaska Airlines [1]	3,956	2,085	510	1,922	771	653	823	10,720	(883)
A. Coastal/Ellis	971	1,104				1,262	178	3,515	(112)
Alaska	1,075	1,019	178	908	925	642	514	5,261	134
Cordova	414	328				537	59	1,338	115)
Hawaiian	1,861	1,645	231	1,517	1,114	977	593	7,938	(153)
Kodiak [1]	161	108				122	64	455	46
Ne. Consolidated	873	841				1,247	290	3,251	208
Pacific Northern	4,281	2,200	895	2,684	1,116	853	1,557	13,586	(338)
Seave Aleutian	867	676				840	225	2,428	319
Western Alaska	105	70				120	47	342	115)
Wien Alaska	1,916	1,670				2,080	219	5,885	111
Alaska & Hawaiian Total	16,538	11,746	1,814	7,031	3,928	9,333	4,569	54,921	(698)
HELICOPTERS									
Chicago	385	625				698	337	2,041	115
Los Angeles [1]	470	519				871	198	2,058	70
New York	852	1,196				1,764	602	4,414	(116)
Helicopter Total	1,785	2,340				3,331	1,137	8,513	69
CARGO & OTHER									
AAXICO	3,264	1,518				592	1,214	6,588	543
Aeravias	975	351	73	286	90	207	48	2,030	1296)
Avalon	179	110				226	45	560	46
Flying Tiger	15,266	12,536	1,474	5,620	1,645	1,824	5,961	44,526	2,811
Riddle	10,597	5,724	995	2,145	504	1,366	2,802	24,133	1865)
Seaboard	5,687	4,649	682	3,228	1,207	1,358	3,011	20,022	1,017
Slick	7,963	4,297	371	2,133	139	1,052	3,690	19,645	1,262
Total Cargo & Other	43,931	29,385	3,595	13,412	3,785	6,625	16,771	117,584	4,518
Industry Total	896,374	639,188	234,362	538,796	381,158	158,329	401,475	3,249,682	53,104

[1] Data is for year ending Sept. 30, 1962. [2] Preliminary report.

Prepared by Bay & Bay

AIRLINE OBSERVER

► Japanese officials have been consulting with Eastern Air Lines President Malcolm MacIntyre on plans to begin a Japan Air Lines shuttle service between Tokyo and Osaka similar to Eastern's Washington-New York-Boston Air Shuttle.

► Seasonal traffic increase began to appear last month when scheduled air lines recorded a 6.6% gain in revenue passenger miles over the same period last year. First-class traffic continued its downward trend, reaching an industry load factor of 46.6%, based on a 10.3% March drop in revenue passenger miles. Coach traffic for the month climbed 16.8%. Coach load factor was 54.4% compared with 51.7% for all categories of traffic.

► Rep. Albert Thomas (D.-Tex.) has indicated he will conduct a field survey of local service airline operations later this year.

► Douglas is offering a center-section fuel provision on the DC-9 short-haul jet which would increase total tankage from 3,004 gal. to 3,834 gal. Maximum takeoff weight would be boosted from 77,000 lb. to 83,000 through stronger landing gear and wing structure. Without center-section fuel the DC-9 has a range from 250 stat. mi. with a full 18,000-lb. payload to 950-1,000 stat. mi. with a 10,000-lb. payload. Extra fuel would give a range of 1,400 stat. mi. with a 10,000-lb. payload and 725 stat. mi. with a full payload.

► Commercial operators dependent on Military Air Transport Service contracts are concerned that introduction of the Lockheed C-141 jet cargo transport will expand MATS airlift capability to the point where it may reduce the business now contracted out. Richard S. Nye, deputy director of the Aeronautical Systems Div.'s airlift modernization center, said recently that on the route between Travis AFB, Calif., Manila and Tokyo, 17 C-141s can do the job currently requiring 114 C-124s, each carrying a 50,000-lb. payload. MATS has yet to disclose how many C-141s it will order.

► Recently completed Aeroflot economic study indicates that the Russian airline monopoly has successfully met the demand for long-haul services in Siberia, but that expansion of short-haul operations would provide a major traffic increase. The survey showed an 83% total load factor for turbine-powered transports flying between Moscow and Novosibirsk and 78% total load factor on the return Novosibirsk-Moscow run. Piston-engine powered Il-14s still flying between Novosibirsk and Irkutsk via Krasnoyarsk maintained a 95% total load factor last year. The study indicated that where load factors have slipped on local Siberian lines, the addition of more intermediate stops would quickly remedy the situation.

► Air-India is now performing its own engine overhaul at its new maintenance base at Bombay's Santa Cruz airport. Overhaul was formerly done by Rolls-Royce. Carrier will handle both Rolls-Royce Conway and Pratt & Whitney JT3D-3 engines at the base, and hopes to obtain overhaul contracts from other carriers with Far East operations.

► British Air Registration has increased to 4,000 hr. the time between overhaul on Rolls-Royce Dart 510 turboprop engines powering British European Airways Viscounts.

► Boeing Co. has developed a cabin cooling system for supersonic transports. To prevent blankets of insulating material and inner cabin walls from absorbing air friction heat on aircraft flying at Mach 3, the new system will discharge air-conditioned cabin air through porous insulating blankets. Air will absorb aerodynamic heat and carry it through collecting ducts into a manifold where it will be channeled overboard.

► One reason for Aeroflot's long delay in placing twin-turboprop An-24 transports in scheduled service was the Antonov aircraft's failure to achieve design speed. Problem was corrected by changing the configuration of the nose and engine nacelles, although consideration had been given to installing more powerful engines.

SHORTLINES

► Air France will expand its summer schedule of flights to Paris from 39 to 56 jet departures a week from North American gateways. Meanwhile, Air France reported that its traffic on the transatlantic route rose 29% during March, compared with March, 1962.

► Air-India has reported a $4.8 million profit for 1962. Carrier's heaviest traffic during the year was generated on the Bombay-London route, where Air India has the most frequency of any airline. Transatlantic traffic increased 60%, a direct result of Air-India's inauguration of daily New York-London service in mid-1962.

► Allegheny Airlines President Leslie O. Barnes has estimated the carrier's traffic will increase about 15% annually during the next three years. He also expects the airline's charter division, activated in January, to gross $1 million in 1963.

► British Overseas Airways Corp. will begin daily non-stop service between New York and Glasgow on June 9.

► British West Indian Airways carried 22% more passengers in 1962 than in 1961.

► Federal Aviation Agency and Civil Aeronautics Board will establish a school to teach accident investigation techniques at the FAA Academy, Aeronautical Center, Oklahoma City. Both CAB and FAA personnel will be trained there.

► Flying Tiger Line air freight traffic increased 14.2% in March over the same period last year, the third consecutive month the airline has reported an increase.

► Jamaica has joined the International Civil Aviation Organization, to become the group's 100th member state.

► Three Douglas DC-7s have been purchased from British Overseas Airways Corp. for $1.2 million by Frederick B. Ayer & Associates, aircraft dealers. Aircraft will be leased to Saturn Airways of Miami, a supplemental carrier which will use them to expand charter operations.

► U.S. domestic trunk and all-cargo airlines flew 192.9 million ton miles of air cargo in the first quarter of 1963, an 8.2% increase over the 178.4 million ton miles handled in the same period last year.

Mariner Design Modified for Mars Flyby

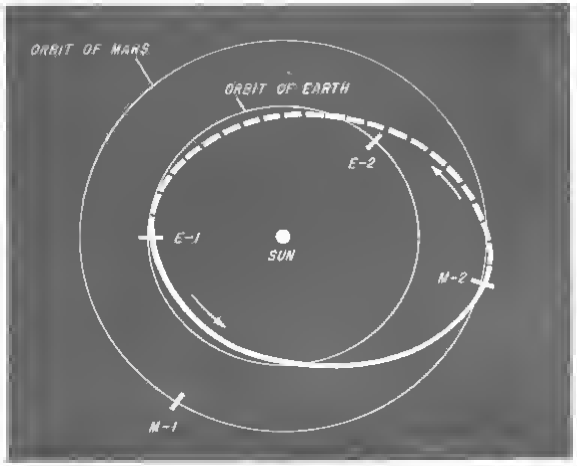
By Irving Stone

Los Angeles—Mariner C Mars-flyby spacecraft, the next National Aeronautics and Space Administration planetary probe, will be programed to pass the planet at a distance of approximately 13,500 mi about 230 days after launch from Cape Canaveral, Fla., in November, 1964

A follow on space experiment to the successful Mariner R Venus probe (AW Mar 4, p 30), the Mariner C Mars mission will include

- **Spacecraft** weighing approximately 600 lb, including 60 lb of scientific instruments and boosted by an Atlas/Agena D combination
- **Ideal launch** date of Nov 19, 1964, with respect to energy requirements, in a minimum launch-period span of 15 days between Nov. 12 and 26.
- **Attitude stabilization** for the spacecraft during the mission using the sun and the star Canopus for reference objects
- **Aim point** to have the vehicle pass the illuminated side of Mars, with the scan plane oriented approximately normal to the Martian equator
- **Series of television pictures** and infrared spectrometer readings to be taken during the flyby for transmission to earth The planet will be within the field of view of the spacecraft instruments during a 20 min period—the acquisition phase—near the time of closest approach
- **Mission termination** 20-40 days after the planet flyby Effect of increasing range plus antenna pointing error is expected to exceed the communication threshold by then

The Mariner C Mars experiment is being managed for NASA by California Institute of Technology's Jet Propulsion Laboratory, which also conducted the Mariner R Venus flyby experiment JPL is pushing work on the Mariner C and contracts for subsystems have been awarded



ORBIT REPRESENTATION for Mars Mariner C spacecraft shows general condition for 1964 window Ideal launch date would be Nov 19, 1964, with closest approach to Mars on about July 8, 1965 Plane of spacecraft orbit will be about half a degree out of the plane of the ecliptic Initial earth parking orbit will be 100-mi.-altitude circular path Points E1 and M1 indicate position of earth and Mars at time of launch Points E2 and M2 represent positions at time of spacecraft's closest approach (13,550 mi) to Mars, about 167 deg around the sun, when direct separation distance between the planets would be about 129 million mi Theoretically, orbital ellipse aphelion is 147 million mi, perihelion 90 8 million mi Orbit is shown flattened somewhat to emphasize the Mars/spacecraft orbital paths cross-over point, which otherwise would be indistinguishable on scale of sketch. Also, perturbation effect of Mars on close encounter with spacecraft would cause it to lose energy and bring its return orbital path inside that of the theoretical shown by the dotted line, creating a smaller ellipse

Mariner Configuration

Configuration will be an extension of the Mariner R Venus design with specific modifications for the Mars flyby Basic configuration is an octagonal structure enclosing eight bays to accommodate equipment Seven of the bays provide a volume of 4 65 cu ft, about 55% more than Mariner R, for housing guidance and control, communications, power, science subsystems, etc

Four solar panels having a combined area of 70 sq ft are attached to the basic spacecraft structure They are positioned nearly vertically for launch and are erected on separation of the spacecraft from the launch vehicle The panels will be oriented to within ±2 deg of being normal to the sun to realize their full capability Sun-spacecraft minimum range will be 90,000,000 mi., and will not exceed 150,000,000 mi until completion of the Mars post-encounter phase

Solar pressure vanes are attached, in an angled position, to the end of each solar panel

A TV camera and an infrared spectrometer are mounted on the bottom of the spacecraft The television system (AW Sept 3, 1962, p 59) will provide 200 x 200 line pictures with approximately 2 5 km resolution for a miss-distance of 25,000 km from the center of the planet or approximately 13,550 mi from the planet's surface. The spectrometer will provide spectral data pertaining to the Martian surface in the region between 5 1 and 6 6 microns and between 1 7 and 2 2 microns

Various scientific instruments on the spacecraft will probe and record physical phenomena along the Mariner trajectory path between earth and the region of Mars

A tube with a diameter of 4 in and a length of 6 ft will project through the spacecraft support cone on top of the octagonal structure to carry a magnetometer, ion chamber, and particle flux detector

Data on fluctuation in the interplanetary field will be provided by the magnetometer and it will measure magnetic fields of Mars The ion chamber/Geiger Mueller counter package, similar to that used with Mariner R, will measure ionizing radiation in interplanetary space and near Mars

A solar plasma detector mounted on the side of the spacecraft octagonal compartment, will measure flux of the positive and negative components of plasma traveling outward from the sun and will correlate these measurements with those from the magnetometer

Direct measurements of the momentum of dust particles in space for determination of particle mass energy and velocity will be done by a cosmic dust detector mounted on the spacecraft support cone

The magnetometer, ion chamber and solar plasma and cosmic dust detectors will be turned on immediately following separation of the spacecraft from the Agena D booster and will remain on throughout the flight

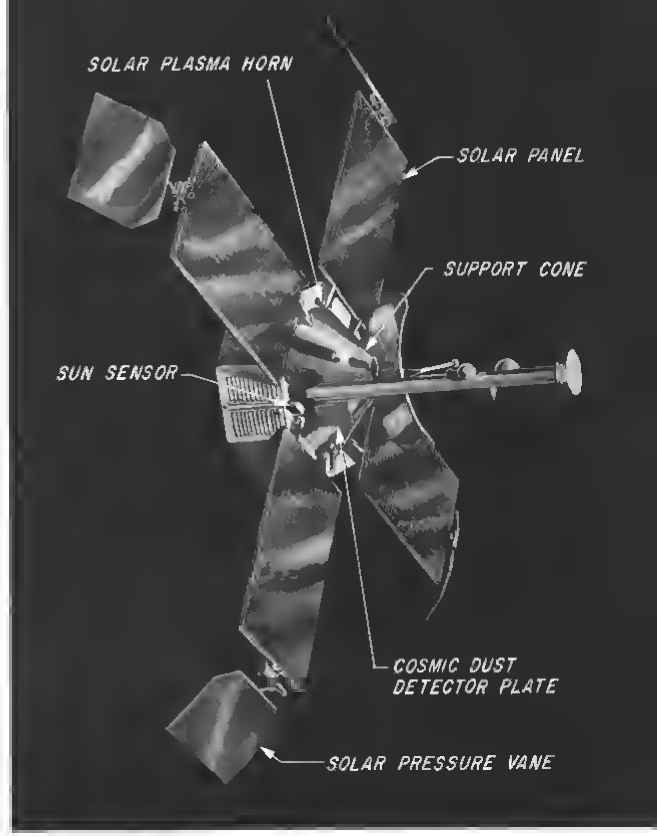
Two sun sensors are located on the top and bottom of the octagonal compartment The Canopus star tracker is positioned on the bottom of the compartment Yaw jets are located on the end of two opposite solar panels and pitch and roll jets are located at the ends of the other two solar panels

To provide command capability and for angle tracking Doppler and ranging for orbit determination the spacecraft carries a two way communications systems for telemetering data to earth The guidance system provides for trajectory correction maneuvers

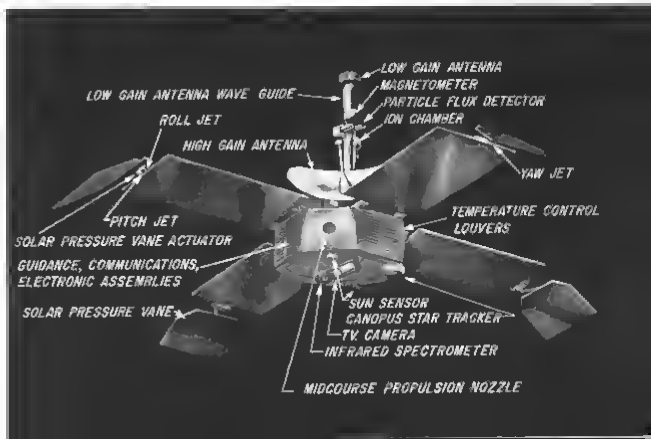
An elliptical parabolic high gain antenna 21 x 46 in. is carried on the top, or forward end of the spacecraft with the RF axis permanently oriented This axis will be pointed at the earth at the time of the encounter with Mars

For the first two thirds of the trajectory the low gain antenna will provide the path for the earth to spacecraft channel Switchover to the high gain antenna will occur on command from the spacecraft's central computer and sequencer at the trajectory point where the earth-to-spacecraft channel signal level reaches the design threshold Back up capability will be provided by ground command On-board logic will return the receiver to the low gain antenna automatically if the receiver loses the earth's signal and does not regain it for 24 hr The low gain antenna is mounted on top of the spacecraft support tube, which also serves as a wave guide for the antenna

Spacecraft temperature probably will be maintained by passive techniques, aiming at a thermal balance between solar heat input electrical dissipation, radiative and conductive paths and heat radiated from spacecraft external surfaces Thermal shielding will provide maximum isolation from solar heat inputs to minimize the effect of the changing solar constant Louvers are



TOP VIEW OF MARINER C Mars flyby spacecraft is shown oriented toward the sun. Experiments are detailed. The NASA planetary probe is programed to pass the planet at a distance of approximately 13,500 mi, about 230 days after launch from Cape Canaveral



being considered if the passive devices cannot provide adequate temperature control. Proposals have been submitted to JPL by industry for 21 pre-production louver assemblies for the Mariner C vehicle.

Propulsion system for the spacecraft is designed to be removable as a unit. The thrust chamber and nominal thrust vector is located normal to the spacecraft roll axis and for midcourse maneuver accuracy the undeflected thrust vector will lie within 10 milliradians of the spacecraft center of gravity. The propulsion system will have a nominal vacuum thrust of 50 lb and will be capable of two starts. Thrust vector control will be accomplished with jet vanes to deflect the exhaust stream through ±5 deg. The system will be able to provide a velocity increment as small as 0.1 meter/sec to the 600-lb spacecraft, but tankage will be sized to provide a maximum velocity increment of 80 meters/sec. Motor burn time within an accuracy of ±0.02 sec will be controlled by the spacecraft's guidance and control system.

Launch Trajectory

For the trajectory from the earth parking orbit a type I, class 1 transfer orbit will be used. This would intersect the target planet at 180 deg or less around the sun.

Total firing period for the mission is 28 days, and the daily firing window is at least 2 hr. For the selected firing period, a set of trajectories will be established incorporating two fixed arrival dates spaced five days apart, and selected to approximate minimum energy launch conditions.

During the initial acquisition phase, the spacecraft will be separated from the Agena D with a velocity increment controlled to ± 2 meters per sec. The solar panels will then be unfolded, science instruments—not including TV and infrared experiment—will be activated, and the attitude stabilization and acquisition process initiated. Solar acquisition nominally will be completed within one-half hour after injection, and Canopus acquisition will require an additional hour.

During the majority of the transit time, the spacecraft will remain attitude-stabilized and will transmit data continuously. This information will consist of commutated engineering data frames alternating with science data frames.

Within 10 days after injection, the cruise phase will be interrupted for the trajectory correction maneuver. Although minimum velocity requirements will occur 6-8 days following injection, an attempt will be made to perform the maneuver sooner in order to improve orbit redetermination. The spacecraft will be programed to perform one midcourse correction based on a determination of the orbit from ground tracking data. A backup capability for performing a second midcourse maneuver will be available. During maneuver sequences no science data will be transmitted.

Exact aim point cannot be established until actual injection errors for the spacecraft have been determined because maneuver execution errors are proportional to the injection errors. Nominal aim point, approximately 13,550 mi from the surface of the planet near the equatorial plane, is as close to the planet as midcourse accuracy will permit and probability of the spacecraft striking the planet will be less than one chance in 10,000. Other conditions chosen to satisfy the aim point are that the Canopus-spacecraft-planet near-limb angle not be greater than 36 deg for 99% of the flyby dispersions and that the sun not be occluded by Mars.

It is desirable also that the earth not be occluded by Mars.

Maximum Range

Maximum range of closest approach for optimum planetary observations is about 22,900 mi. from the surface of the planet. It is expected that useful data could be obtained as far out as about 125,000 mi from the surface of the planet.

Nearest approach of the spacecraft must be keyed to the Goldstone deep space instrumentation facility (DSIF) to take advantage of the backup capability of the station's 100-kw transmitter.

The encounter phase will consist of a 13½ hr period bracketing the time of closest approach to the planet. The television camera, infrared spectrometer, and planet scanner will be energized approximately 6½ hr before the point of closest approach and remain energized until the conclusion of the 13½ hr encounter period. The planet will be within the field of view of the instruments for approximately 20 min near the time of closest approach. During this period, known as the acquisition phase, TV and infrared data will be stored on a tape recorder having a capacity of 5 million bits, permitting storage of 20 pictures each.

Instrument Scanning

The television and spectrometer instruments will be bore-sighted and have a single degree-of-freedom scan. Plane of the scan will be oriented approximately perpendicular to the Martian equator. The vehicle's motion will afford movement of the scan plane roughly parallel to the Martian equator. Planet acquisition will be identified by a radiation transducer which will sense and track the illuminated surface of the planet. The scan pattern will be triangular with fixed amplitude stepping controlled by internal logic.

The spacecraft's central computer and sequencer will turn on the planet science and scan subsystem, apply power to the tape recorder, uncover science instruments and unlatch the scan platform.

The scan system will signal the spacecraft's data automation system that it has acquired the planet with the wide-angle sensor and begin tracking. The data automation system will begin encoding the TV and infrared instruments but no data will be sent to the tape recorder because this equipment will not yet be viewing the planet. The data automation system will send a signal to the encoder to switch to the data mode to be used during the en-

Mariner C Prelaunch Sequence

Operations and precautions in readying the Mariner C spacecraft for launch at the Atlantic Missile Range, Cape Canaveral, Fla., will consist of:

- Mariner C mating to the Atlas/Agena D boost vehicle at least three days prior to inception of launch period.
- Prelaunch checkout, involving all elements of the launch complex, at least two days prior to launch.
- System loop checks performed only after Mariner C has left the final assembly area.
- Spacecraft-to-blockhouse functions restricted to those required to turn the spacecraft on and verify that it is in flight condition. There will be no other connections to the spacecraft while it is mated with the launch vehicle. Blockhouse will have no provisions to test Mariner C components or subsystems.
- Access to spacecraft on the booster will be restricted after shroud installation. If access is required the spacecraft will have to be removed from the boost vehicle with the shroud intact and returned to the hangar. Recycle time in this case is estimated to be about 22 hr., plus the operation time required on the spacecraft.

During countdown there will be a capability of holding indefinitely without recycling, prior to X −8½ min. If a hold occurs after this time, there will be a capability of holding for an accumulated interval of one hour without recycling unless the hold is called for the spacecraft when it will be necessary to recycle to X − 8½ min.

If a launch is scrubbed and access to the spacecraft is not required, the system will have to be capable of being rescheduled for a launch time within a 20-hr interval.

counter phase, and real time data of the TV, infrared and scan will be transmitted.

Signals from the TV and infrared equipment will indicate when their view is on the planet and a narrow-angle acquisition signal will be sent to the data automation system to prepare the scan for the programmed sequence.

First View

TV and infrared equipment will have been cycling continuously in 80-sec sequences, and when the planet first moves into view it may require as much as 80 sec before the cycle will be at a correct point to take a picture and send the data to the tape recorder. The scan then will begin a program sequence to cover the planet in a stepped sawtooth-pattern sweep while TV and infrared information is recorded at each step.

When the tape recorder is full, a signal will be sent to the data automation system to switch the recorder to the appropriate data mode, and TV and infrared sequencing will stop. In the post-encounter phase, the stored data will be read out continuously and repetitiously unless interrupted by ground command.

Guidance-Control System

The guidance and control system incorporates the central computer and sequencer, which provides timing, event initiation sequencing, switching, and computing operations for the spacecraft. It accepts, stores, and executes guidance and attitude commands from the telecommunications system.

The guidance and control system's attitude control subsystem will operate in the acquisition and cruise mode, maneuver mode, and for inertial roll. Attitude control gas supply will be three times the maximum calculable consumption.

Mars Pictures

Mariner C television pictures and infrared spectrometer sensing of Mars should resolve conflicting concepts concerning the Martian surface.

Visual observation of this planet has produced more general knowledge than of any other in the solar system, and the fully illuminated disk in the 1965 flyby should afford the opportunity for TV and IR spectrometer to record physical characteristics with high degree of accuracy.

Comparison with pictures which may be obtained this June by the Soviet Mars vehicle will afford a double opportunity to verify Mars topographical variations by different instrumentation and trajectory conditions.

Mariner C Flight Sequence

Event	Time*
Launch sequence started	T −3 min.
Liftoff	T +0
Solar panels and solar radiation pressure stabilization system deployed	S +1 min.
Attitude control system turned on	S +2 min.
Sun and Canopus acquisition completed	I +10 to 100 min.
Solar radiation pressure system turned on	T +997 min.
Tracking completed and trajectory commands sent	T +1 day
Maneuver sequence started (gyros turned on for warm up)	M +0 to 1 min.
Maneuver to correct trajectory begun	M +60 min.
Midcourse motor ignited (burns for up to 81.8 sec.)	M +104 min.
References (sun and Canopus) automatically reacquired	M +110 min.
Canopus sensor cone angle No. 1 set	E −160 days
Canopus sensor cone angle No. 2 set	E −126 days
High gain antenna used for transmitting, low gain used for receiving	E −114 days
Canopus sensor cone angle No. 3 set	E −93 days
Encounter scan limits cycled (programed limits adjusted wider for closer pass of planet, and narrower for far pass)	Ground Command
High gain antenna used for transmitting and receiving	E −100 to −20 days
Canopus sensor cone angle No. 4 set	E −50 days
Encounter science turned on (TV, infrared, and tape recorder get power but do not start sequence. Scan system rotates platform from limit to limit.)	E −6⅔ hr.
Wide angle acquisition used (Scan system acquires planet, begins tracking. TV and infrared cycled, but no data sent to tape recorder because planet is not yet being viewed. Real time data of TV, infrared, and scan are transmitted.)	E −97.2 to −38.5 min.
Narrow angle acquisition used (signals from TV and infrared indicate when view is on planet. Scan is reset.)	E −15.5 to −10.2 min.
Recording begins (up to 80 sec required after planet first moves into view before picture is taken). planet in view for about 20 min. near time of closest approach	
Spacecraft closest approach to Mars	E +0
End of tape in recorder	E +4.5 to 10.2 min.
Encounter science switched off	E +6⅔ hr.
Tape playback begun	E +13⅓ hr.

*T—Time of liftoff
S—Spacecraft separation
I—Injection into transfer orbit
M—Maneuver sequence
E—Encounter sequence. Encounter phase is defined as the 13⅓ hr. period bracketing the time of closest approach to Mars. Encounter is the point of closest approach.

Cumulative effect on the attitude control gas supply of any rotating or reciprocating component will be less than 5% of the total calculable consumption.

Four data modes will function for effective use of data channel capacity during the various mission phases. Mode 1 will be used during maneuvers, and only engineering data will be sampled. The mode also may be used to increase engineering data sampling during cruise to aid in failure analysis, if required. Mode 2 will be used during the launch phase, initial acquisition, and cruise. Blocks of engineering data 140 bits long will be alternated with blocks of science data 280 bits long. Mode 3 will be used during the encounter phase while the TV and infrared systems are scanning the planet. Only science data will be sampled in this mode.

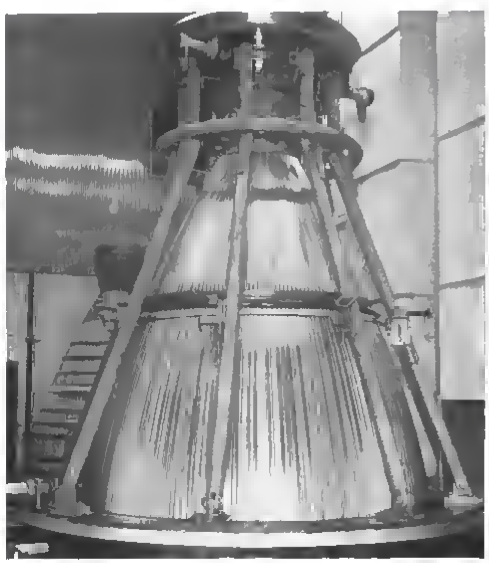
Mode 4 will be used for playback of stored science data from the tape recorder.

Selection of data modes will be possible by both ground command and on-board logic. Data will be transmitted in digital form. Required resolution for the analog measurements will be 1% of full scale.

Telemetry subsystem will be capable of accommodating not more than 100 commutated measurements, including synchronous, framing, and subcommutation requirements.

Digitized data will be capable of transmission at either 8⅓ or 33⅓ bps. Command bit rate will be 1 bps. The storage system will be capable of reading in at a bit rate of 13,200 bps.

The Manner C storage system will be able to read out synchronously with the telemetry system at a bit rate of 8⅓ bps.



ROCKETDYNE J-2 ENGINE (right) shown in "hard" mockup is designed for 200,000 lb thrust in vacuum. Engine is about 10 ft high, has a 6.5 ft. dia exit nozzle. J-2 engine fabrication begins with clustered stainless-steel tubes (left) which conduct the liquid hydrogen down half the length of the combustion chamber nozzle and back to the injector head. Tubes are held in this "bird-cage" fixture and brazed in assembly process

J-2, M-1 Engine Design Details Reported

By David A. Anderton

Washington—First production deliveries of Rocketdyne's J-2 upper-stage rocket engine, one of two large liquid hydrogen-liquid oxygen powerplants being developed for National Aeronautics and Space Administration, will start this summer.

The other engine program—Aerojet-General's M-1 upper stage engine—is in the stage of hardware fabrication. Test stands, liquid hydrogen storage facilities and manufacturing facility expansion are nearly complete.

First design and engineering details on both these engines were reported here recently at the National Aeronautical Meeting of the Society of Automotive Engineers.

J-2 program now is in the stages of system refinement and reliability investigation, said W. R. Studhalter, who is the program manager for the engine at North American Aviation's Rocketdyne Div. Several thousand component tests are scheduled for the next two years. Preliminary Flight Rating Test (PFRT) is scheduled for completion this year, and engine qualification and first flights are programed for 1965.

Burning liquid hydrogen fuel and using liquid oxygen oxidizer, the J-2 engine delivers 200,000 lb. thrust at altitude. It retains the capability of being tested at sea level conditions for checkout and development of reliability. Consequently, the expansion ratio of the engine thrust chamber is 27.5:1, to achieve maximum possible altitude performance without compromising the ability to make sea-level tests.

Basic layout of the engine starts with the thrust chamber, which will be gimbal-mounted to allow angular deflections up to 10 deg. for vehicle stability and control. All components are mounted on the thrust chamber.

Separate turbopumps, driven by exhaust products from a gas generator, are mounted on each side of the thrust chamber. Liquid hydrogen is pumped by a seven stage axial-flow pump rotating at more than 25,000 rpm. It has a two-stage turbine. Oxygen pump is a radial type and operates at approximately 6,000 rpm. Its turbine is also a two-stage unit.

Each of these pumps is lubricated by its own working fluid. In the oxygen pump the bearings have an internal bypass flow of 20 gpm. of liquid oxygen, thus passes through both bearings in series. Liquid hydrogen flow at 10 gpm. is provided for each of the two bearings in the hydrogen turbopump. Internal thrust of the pump units is balanced by the by-pass-propellant flow to prevent any axial loading of the bearings.

Helium-operated valves, an electrical control and ignition system, hydrogen and oxygen gas tanks for pressurization, flight instrumentation and connections complete the layout of the engine.

Thrust chamber follows the tubular construction mode developed earlier on rocket powerplants. The J-2 engine uses "pass-and-a-half" cooling, a technique used on the Pratt & Whitney RL10A series of engines (AW Apr. 2, 1962, p. 52). But rather than use an equal number of intake and return tubes Rocketdyne designers specified a 1:2 ratio.

Hydrogen enters through a manifold about halfway down the engine and flows through 180 tubes to a return manifold. The manifold distributes the flow through 360 tubes which carry the hydrogen to the injector inside the combustion chamber.

During the flow process the hydrogen gas, which entered the manifold intake at more than 800 psi. pressure and approximately its −423F liquid temperature warms to about −260F. At this temperature and the pressure inside the tube the hydrogen is gaseous and is burned in the combustion chamber.

Thrust Chamber Design

Stainless steel tubes which form the thrust chamber were designed with the aid of an iterative computer program. This was necessary because of the large variations in flow parameters which required correspondingly large variations in the tube cross-sections. Flow velocity for example, varied from 60 ft./sec. to 1,000 ft./sec.

Rocketdyne designers also took advantage of the difference between the number of intake and return tubes to provide a space for exhausting the turbine exhaust into the combustion chamber. At the nozzle midpoint just above the inlet manifold for the liquid hydrogen, a second manifold distributes the turbine exhausts through 180 holes formed by triangular gaps between the cooling tubes.

Starting cycle originally was planned as the "bootstrap" type used by P&W on the RL10A, but the time required by the cycle for acceleration to full power was too long for the application of the J-2 in the Saturn upper stages.

Augmented Start

Consequently, Rocketdyne specified an augmented system which uses a compressed hydrogen gas stored in a sphere with a volume of four cubic feet. The hydrogen is expanded through the turbines during the starting cycle to give a rapid spin up of the turbopump assembly. This system has the advantage of being re-chargeable during flight for multiple restarts following coasting periods.

For normal operation of the turbopump system once the cycle has been started, liquid hydrogen and liquid oxygen are burned in a gas generator in a fuel rich environment. The exhaust drives the hydrogen pump turbine first, then passes to the oxygen-pump turbine. After leaving that unit, it is discharged through the manifold into the thrust chamber.

Studhalter said the electrical system for the J-2 engine contributes about 15% of the total cost of the powerplant. The major reason for its cost is the advanced design of the circuitry, which has to operate through a temperature range between −300F and +140F in addition to surviving the other rigors of rocket-engine environments.

Final design of the electrical system utilizes more than 1,000 components. connections are made with cabling capable of withstanding 1,500F.

One of the problems inherent in the design of an engine using liquid hydrogen is that the surface temperatures become so low that air liquefies on the surface. Streams of liquid air create frost and condensation problems and also form a serious heat leak. Rocketdyne has designed vacuum jackets for the hydrogen ducts and pump.

Major difficulty in the duct design stems from the gimballed engine whose motions are transmitted to the duct. This duct is 21 in. long, and must withstand compression and extension of ¾ in. each plus angular deflections and twist. The vacuum jacket for the duct is a double bellows.

Problems of joint sealing were eliminated wherever possible by using welded connections. But this has not been practicable in 112 locations where seals had to be used [illegible]. Rocketdyne has developed a proprietary pressure-actuated combination seal to meet a specification of zero measurable leakage. It is used throughout the J-2 engine for liquid hydrogen and oxygen, helium and generator hot-gas sealing. Largest of these seals is 19.48 in. in diameter.

J-2 Test Stand

Five test stands are being used in the J-2 development program, and two of them incorporate altitude simulation. They were developed to maintain a 60,000 ft. pressure altitude in an engine capsule during complete start, run, stop and restart cycles.

For continuous running the engine is self-aspirating through a diffuser downstream of the nozzle. During starting or shutdown cycles, the engine pumping is replaced by an annular steam ejector working in conjunction with a second throat downstream.

Mechanical gimbal actuator has been developed by Rocketdyne for the J-2 test stand firings. It uses a ball-bearing screw to give an actuation force of 42,000 lb. It is a self-contained unit that

ROCKETDYNE J-2 engine test stand Delta 2 has a 90,000 gal. jacketed liquid hydrogen storage tank (center) flanked by two 20,000 gal. unjacketed liquid oxygen tanks

J-2 LIQUID-HYDROGEN turbopump, shown before testing, is driven by exhaust from a gas generator. Unit has a seven-stage axial-flow compressor and a two-stage turbine.

operates at temperatures down to —300F, avoiding the complexities of hydraulic systems that have to work in such an environment. This design is not yet applicable to flight use.

J-2 development program began in September, 1960, at Rocketdyne. The basic design of the engine was completed in six months, and the first thrust chamber and pumps were fired as an operating unit in January, 1962. First full thrust, full duration run was made last October when the test engine was fired for 250 sec.

Saturn Upper Stages

The engine will be used in upper stages of the Saturn vehicle; five will power the second (S-2) stage of the Saturn 5 and one will drive the third (S-4B) stage of the Saturn 5 and the second (also an S-4B) stage of the Saturn 1B.

J-2 engine is about 10 feet high, from the exhaust face to the top component; nozzle exit diameter is about 6 5 ft. Total engine weight is about one ton. Engine is being developed for NASA's Marshall Space Flight Center, Huntsville, Ala.

Aerojet-General's M-1 engine (AW Apr. 15, p. 33) stands about 25 ft high and has an exit diameter of about 15 ft. Originally planned for a vacuum thrust rating of 1.2 million lb., the M-1 has been uprated in design so that the nominal thrust is now 1.5 million lb.

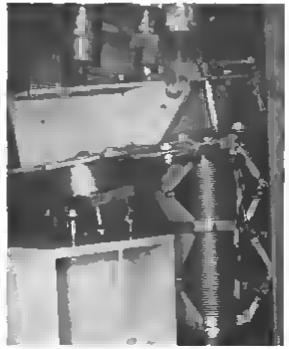
Major use envisioned for the engine is in the second stage of post-Saturn (Nova class) of space vehicles with million-pound payload orbital capability.

First Tests

First component tests are scheduled for this month (AW Apr. 22, p. 73) with the running of the gas generator for the turbopump units. Thrust chamber and pumps are programed for testing before the end of 1963.

Basic design of the M-1 parallels that of the J-2 and most other liquid-propellant rocket engines. Separate liquid hydrogen and liquid oxygen turbopumps are mounted on the thrust chamber, each driven by its own turbine. The hydrogen pump is a multistage axial-flow type, and the oxygen pump is a single-stage centrifugal unit.

Starting cycle is initiated electrically, Aerojet's D. E. Price said. Thrust chamber and gas-generator spark igniters are energized at the start signal. Main



LIQUID-HYDROGEN INLET duct, vacuum jacketed with double stainless-steel bellows, undergoes endurance tests simulating anticipated J-2 engine operation stresses.

propellant valves are opened by helium-action, and the pumps supply fuel and oxidizer to both the gas generator and the combustion chamber. Exhaust from the gas generator accelerates the turbines to steady-state operation.

During steady-state firing, the engine burns more than 3,000 lb. per second of propellants.

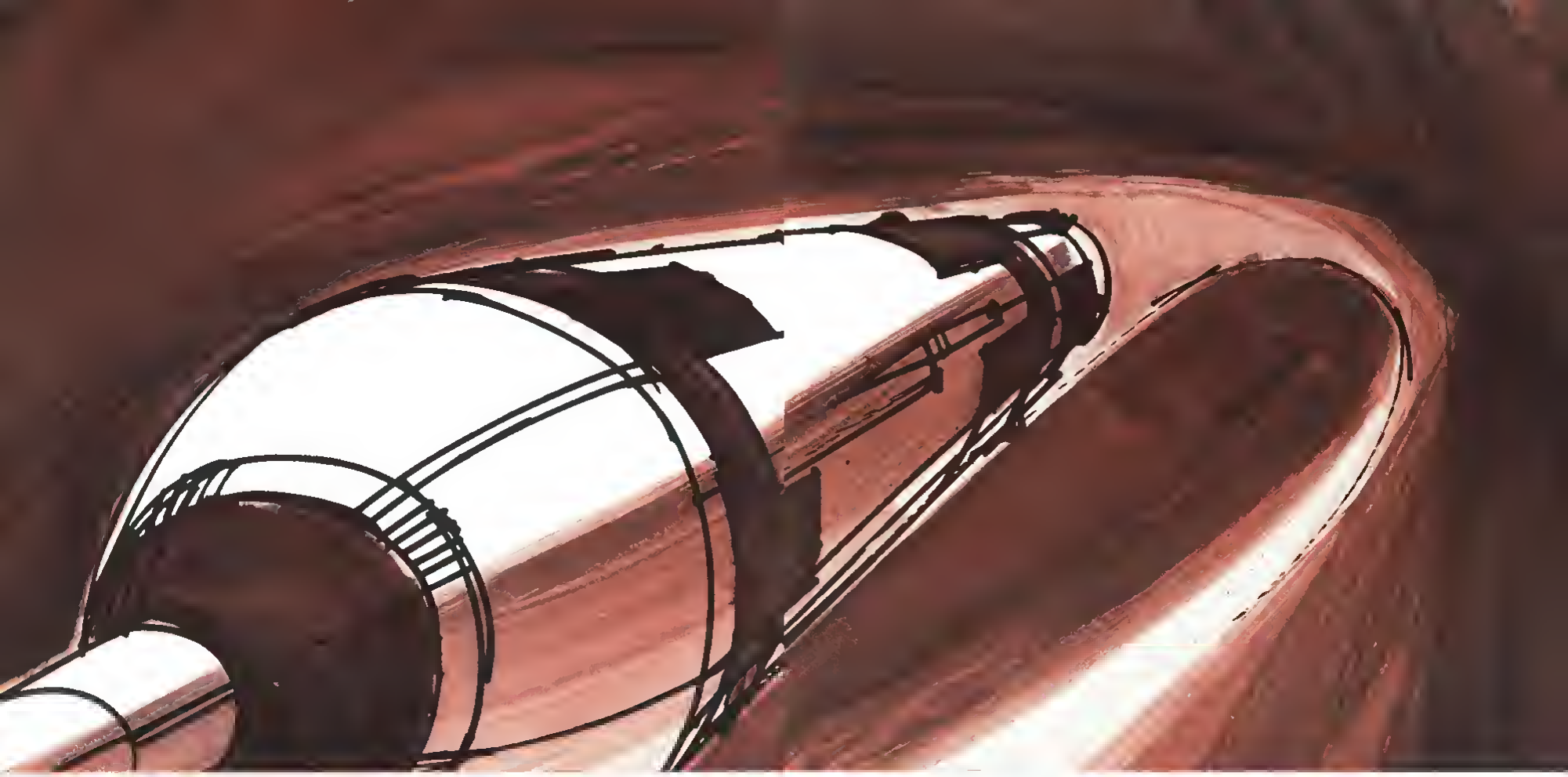
To shut down the engine, the gas generator valve and thrust-chamber valve actuators are vented, which closes the propellant valves to both units and shuts off propellant flow.

Aerojet's liquid-rocket plant facilities at Sacramento, Calif., are being modified in certain areas to handle the development test program for the M-1 engine. Two liquid hydrogen vessels, believed to be the two largest in the world, are installed on the site; each is double-walled, vacuum-insulated and built of stainless steel. One will handle test runs and the other will be a catch and storage tank.

Engine test stands will store enough propellant to run the M-1 up to 500 sec. Total liquid hydrogen storage capacity will be 2.5 million gal.—about 1.47 million lb. of propellant—seven days' maximum production of all the liquid hydrogen production facilities now in operation in the U. S.

M-1 engine is being developed now under cognizance of the Lewis Research Center of NASA. It originated as a development program for the Marshall Space Flight Center. Contract was awarded in April, 1962, originally to develop an engine with 1.2 million lb. thrust.

Since then, the thrust goal has been increased to 1.5 million lb., target. Growth potential has been developed to take the engine to even higher thrust levels.



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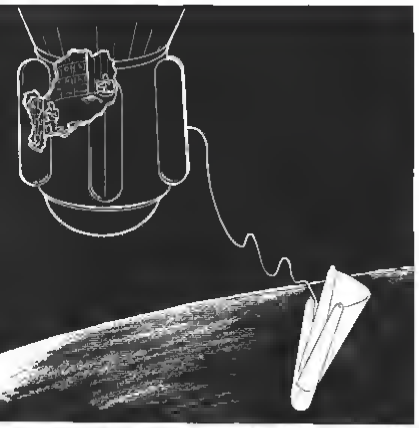
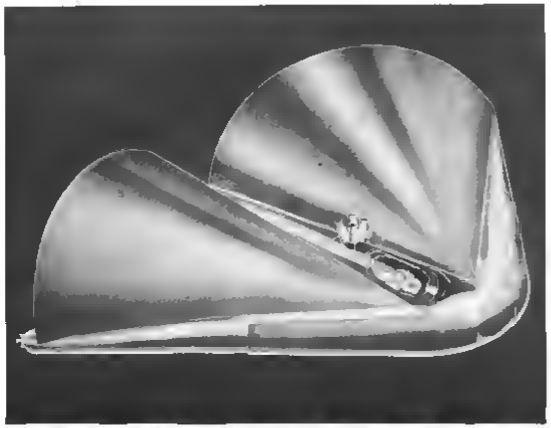
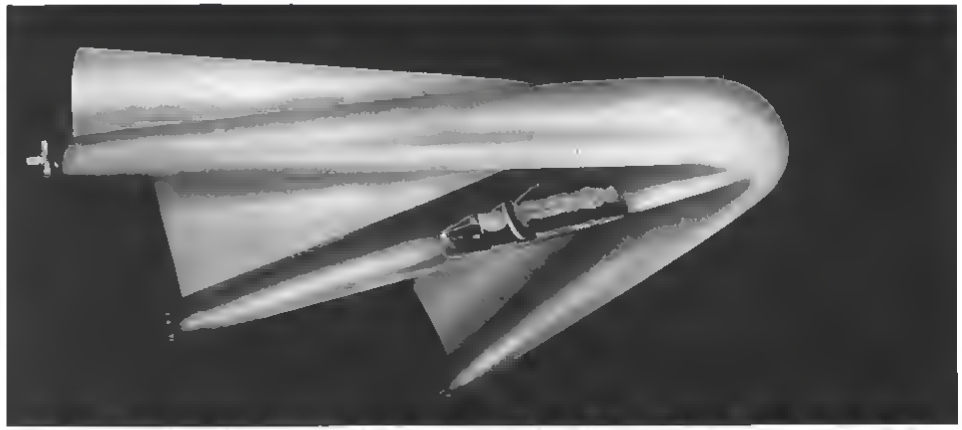






SPACE-GENERAL has conceived its 'space lifeboat' concept as a means of returning the entire crew of a large orbiting space station in the crew capsule located in the keel bottom. At time of paraglider launch sequence, protective canister containing the packaged paraglider will be ejected from the station by the separation mechanism. Package will be snubbed by the cable. At a safe distance, inflation phase will commence with the release of the lacing restraining the canister. Capsule will contain vehicle's life-support system, inflation system's nitrogen tanks and plumbing, and the guidance, control and stabilization package. Earth-return vehicle will consist of a paraglider having a delta gull-wing configuration and a cylindrical event of an abandon-ship condition.

Inflatable Space Station Escape Vehicle Under Study

By Warren C. Wetmore

Development of a space-station escape vehicle in the form of an inflatable re-entry paraglider has become a possibility with the recent award of a $251,000 contract to Space General Corp. from Air Force's Aeronautical Systems Division. The cost-plus-incentive-fee contract—which is to run for a minimum of 14 months—calls for the design, fabrication and testing of various structural segments of an inflatable paraglider, including a wing boom, a keel boom and portions of the wing membrane.

Fabrication is now under way on this program—dubbed Project First (fabrication of inflatable re-entry structures for test) by the company—which is Space-General's second in the area of paraglider technology. Three inflatable micrometeoroid paragliders—(IMP) are being developed under an earlier contract from the National Aeronautics and Space Administration's Langley Research Center (AW Oct. 8, p. 32). The first of two IMP flight models is due to be launched by an Aerobee 150 in mid-May, with the second to follow one month later.

Some of the USAF re-entry paraglider components are being built to IMP scale—about 60% as large—because tooling is available from the IMP project.

During testing, the components will be subjected to static loading under IBM 7090 computer control to simulate bending, shear and torsion airloads encountered as a function of time during re-entry. Simultaneously, the corresponding aerothermal loads predicted by the 7090 will be duplicated by a battery of quartz lamps. Shock and vibration tests also have been scheduled by Space-General.

Space General's space lifeboat was conceived as a solution to the problem of returning the entire crew of a large orbiting space station in the event of an abandon-ship condition. Such a condition could arise from meteoroid penetration, fire, radiation or other circumstances rendering the space station uninhabitable.

The single-place earth-return vehicle will consist of a paraglider having the characteristic delta gull-wing configuration, with a cylindrical crew capsule located in the keel boom. Contained in the capsule will be the passenger's life support system, sufficient for about five hours, the inflation system nitrogen tanks and plumbing and the guidance, control and stabilization package.

Length of the capsule will be 10 ft. and its diameter 28 in., while the tapering keel boom will measure approximately 22.5 ft. over-all and will have an apex diameter of 32 in. Launch weight of the vehicle will be approximately 940 lb. which—with a wing area of 280 sq. ft.—gives a wing loading of 3.36 psf.

For stowage on board the space station, the uninflated wing booms and wing membranes will be furled along either side of the rigid capsule and the aft section of the keel tube folded accordion-style against the aft end of the capsule. This configuration is to be packaged in a flexible resinous canister which is split into two semicylinders along the longitudinal axis. These will be joined by break-away lacing to form a right circular cylinder approximately 3 ft. in diameter and 12 ft. long.

Chief problem in the design of the paraglider is in the selection of materials flexible enough for inflatable structure, yet tough enough to withstand the intense aerodynamic heating of orbital glide re-entry.

Space General engineers are considering the use of Rene 41 fabric as the basic load bearing material. This fabric is woven with 40 strands per inch from twisted fibers of five 0.0016 wires and maintains its strength to about 1,500F.

Fabric will be impregnated with a silicone resin which ablates at temperatures above 1,500F, and which varies in thickness up to a maximum of 0.10 in. according to local thermal loads. Wing membrane thickness will be 0.015 in.

Du Pont "H" film—a Mylar-like plastic which retains its structural integrity at temperatures approaching 1,500F—will be bonded to the inside of the impregnated fabric in the inflatable portions as a gas barrier.

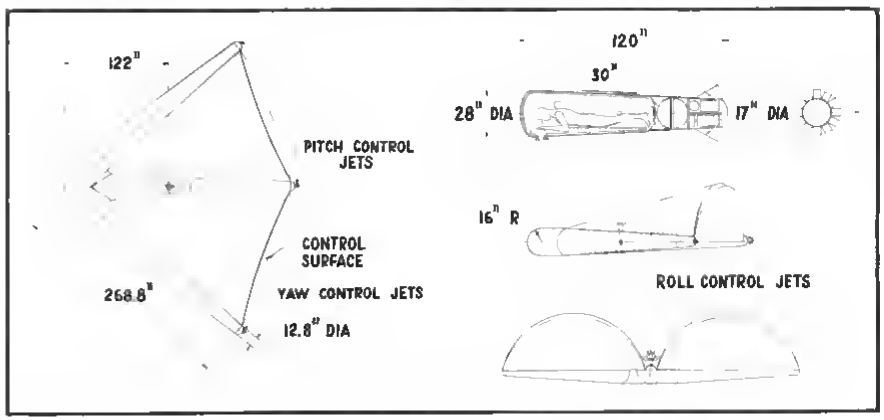
Nose stagnation region will be protected by a laminated refrasil phenolic heat shield of sufficient thickness—0.25 in.—to withstand ballistic re-entry heat loads should the para-wing fail. Normal stagnation point temperature will be approximately 3,200F for a period of six minutes.

Access to the capsule will be through a dorsal mating-type hatch attached to the space station. The occupant will assume a prone position permitting downward visibility through a port for control of landing. Visibility in other directions would be provided through an optical system.

Capsule will be supported and isolated from the keel tube by means of longitudinal nitrogen-filled tubes. Two of the bottom tubes will be strengthened to withstand landing shock.

Flight control system will perform the usual orientation, stability and attitude control tasks necessary for an orbiting spacecraft with the additional requirements for supersonic and subsonic flight. System elements include:

- **Attitude reference subsystem** comprising two body-mounted two-degree-of-freedom rate gyros and readout synchros indicating the pitch, yaw and roll angles of the vehicle relative to the inertial directions referenced by the gyros.
- **Rate gyro package** utilizing three orthogonally-mounted rate gyros which indicate the angular velocities about the three control axes.
- **Axial accelerometer** for determining the vehicle's deceleration.
- **Air data sensor** provides signals in



LENGTH of the capsule will be 10 ft. and its diameter 28 in. Launch weight of the vehicle will be approximately 940 lb.

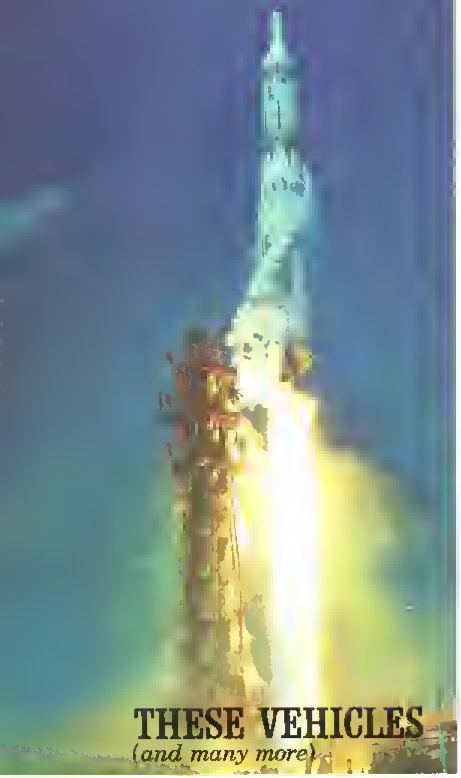
dicating the dynamic pressure, the pressure altitude and the rate of descent

- **Reaction jet subsystem** utilizing nitrogen from the inflation gas supply as a working fluid with flow controlled by on-off solenoid valves Large and small pitching moments are provided by two pairs of large and small thrusters pointing up and down at the aft end of the keel boom, while two pairs of large and small nozzles on the aft end of the wing booms give rolling moments Yawing is accomplished through use of a single nozzle pointing aft at the aft end of the wing booms The paraglider will be pressurized to 20 psig above ambient pressure and excess pressure generated by re-entry heating will be bled equally through the reaction jet system.
- **Flap position control** providing control in the atmosphere by adjusting the length of the cable strung through the trailing edge of the wing membrane Warping the trailing edge in this manner provides the required aerodynamic control moments Under "hands off" conditions—with the control cables at their relaxed length—the paraglider will trim out at some predetermined nominal attitude The length of the cables will be continuously controlled by an electromechanical position servomechanism
- **Avionics subsystem** providing for the programing of the flight control system, autopilot compensation, switching operations, signal processing
- **Electrical power supply** for the flight control system, provided by a 28-volt battery system A static inverter will generate precise 26 v. 400-cycle 2-phase a c for operation of the gyros.
- **Communications channels** for voice contact between the vehicle and ground stations, and for telemetry of necessary flight information Ground tracking will be aided by transponder beacons
- **Instruments and manual controls** necessary for the operation of the flight control system, as well as for control of the life support system

Launch Sequence

Paraglider launch sequence will begin with the space suit-clad pilot entering the capsule—which will be stowed in a protective cocoon outside the space station—through the sealed connecting flange around the entry hatch After securing himself in position he will conduct a systems checkout while the paraglider is still attached to the station and connected through an umbilical cable Station systems will provide accurate attitude reference and trajectory data Crewmen in the station will then close the inner hatch and replace the outer hatch which contains the retrorocket package

The protective canister containing the packaged paraglider will be ejected from the station by the separation



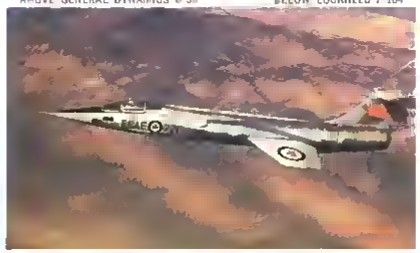

LEFT MARTIN TITAN I


ABOVE FAIRCHILD F 27F


BELOW LING TEMCO VOUGHT F 8E CRUSADER


ABOVE RYAN Q 2C FIREBEE

ABOVE GENERAL DYNAMICS B 58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mechanism. The package will be snubbed by the umbilical cable and then—at safe distance—the inflation phase will commence with the release of the lacing restraining the canister.

To prevent rupture, the inflation phase will be divided into two stages. The paraglider will be formed at 1.0 psig over a period of 90 sec. to permit proper deployment.

Final inflation pressurizes the paraglider to 20 psig.

The inflated paraglider will be maneuvered—using both yaw jets simultaneously to provide forward propulsion—back to a launch platform on the space ship, where the attitude gyros will be aligned. The umbilical cable will be disconnected and the vehicle maneuvered into the proper pitched down retrofire attitude by means of the attitude-control jets.

For the desired range of re-entry flight paths, incremental velocities from 400 to 600 fps are required. With a nominal specific impulse of 260 sec. and a propellant fraction of 0.93, the four retrorockets producing this increment will weigh approximately 90 lb. Their thrust axes will be aligned through the center of gravity of the vehicle along the centerline of the keel boom.

Reaction Jet System

The vehicle will be maintained in the proper attitude during retrofiring by means of the reaction jet system which will provide enough control moment to overcome any moments arising from misalignment of the retrorockets or center of gravity displacement.

Time required to transfer from the circular orbit of the space station at 320 naut. mi. altitude to re-entry is approximately 26 min. Initial re-entry conditions are 940 lb. gross weight, a velocity of approximately 26,000 fps at an altitude of 300,000 ft. and a flight path angle of −2 deg. The desired angle of attack upon entering the atmosphere is 12 deg.

The paraglider will be designed to possess a nominal re-entry lift drag ratio of 0.5 which can be varied by changing the angle of attack. Deceleration is proportional to this ratio during the early portion of atmospheric flight, and will be controlled by the automatic attitude control system which—by means of the signal from the axial accelerometer—corrects the pitch angle to maintain the deceleration below a prescribed level. Vehicle temperatures also will be monitored and they will be kept below the critical value by controlling the level of deceleration.

The increase of aerodynamic forces will be accompanied by heating of the gas supply for the reaction jets. This causes an increase in their specific impulse and thus the jets will become more effective in controlling the vehicle.

Flap position actuation will replace reaction jet control after dynamic pressure—on entering the supersonic flight regime—has mounted to a point where aerodynamic control is possible. Relieving the tension in both control cables will produce a nose-up pitching moment, increasing the tensions will result in a nose-down pitching moment. Rolling moments—and hence yawing moments required to produce a coordinated turn—will be obtained by asymmetrical displacement of the two control cables.

Pitch Attitude Control

Flight control system will be switched to a mode in which pitch attitude is controlled to make the dynamic pressure conform to a precomputed relationship to pressure altitude. Lateral stability will be achieved through the use of the yaw and roll gyros, and roll angle will be controlled in such a manner that the paraglider will fly the heading indicated by the yaw position gyro.

Control force gradients will be unusual inasmuch as increased forces will be required to pitch down or trim at higher speeds and decreased control forces will be necessary to pitch up or trim at lower speeds. Space General engineers recommend that this condition be remedied by incorporating an artificial feel control boost device into the control system in the event of manual override of the automatic system.

By the time the vehicle has decelerated through Mach 1, cooling from re-entry temperature will have reduced the inflation pressure below the 20 psig differential. This loss will not be made up immediately, since subsonic maneuvering of a paraglider is better accomplished with a more flexible structure.

Subsonic lift-drag ratio will be approximately 4.0.

Pitch attitude will be controlled to cause the vehicle's rate of descent to follow a prescribed function of altitude while lateral control will be accomplished in a manner similar to supersonic flight.

Terminal Flight Control

After ground stations located near the desired landing area have acquired the paraglider, terminal flight control—involving adjustment of descent rate and heading—can be made through voice communication with the pilot or by radio command. Vertical velocity reduction for landing will be accomplished by means of an aircraft type flare maneuver, after the paraglider has been repressurized back to 20 psig. Landing skids will not be necessary, since the passenger capsule will be supported pneumatically inside the keel boom, thus enabling adequate absorption of the ground impact loads.

AFSC Cites Lubrication Research Needs

By Erwin J. Bulban

San Antonio, Tex.—Powerplant and systems lubrications requirements of future aircraft and spacecraft pose severe challenges for the petrochemical industry and equipment manufacturers, emphasizing a need for new research efforts to obtain solutions.

Attention was focused on these pressing needs by Air Force Systems Command during its 1963 Aerospace Fluids and Lubricants Conference here.

These include:

- **Lubricants** for advanced turbojet engines capable of maintaining fluid integrity at bulk oil temperatures—the temperature of the oil supplied to the engine—two to three times the current 300F requirement. Improvements will be required in oxidation stability, load-carrying ability and in higher spontaneous ignition temperature.
- **Greases** that will work properly at temperatures at least 50% higher than current materials on rotating elements having speeds approximately double those today.
- **Hydraulic fluids** that will be required to operate at temperatures approximately double those of current products, while maintaining good lubricity, yet having superior low-corrosion and fire-resistant qualities.

Even stiffer requirements will be imposed on these products for use in future spacecraft operating in deep vacuum environments on missions of several years, particularly unmanned.

Fluid Formulations

In an attempt to solve these problems, the using agencies and industry are studying numerous fluid formulations. Both users and suppliers admit that the problems are compounded by the fact that in many cases the engines or equipment to which these lubricants are to be applied are either in extremely short supply or do not exist, greatly complicating development and evaluation of the lubricants.

Even in cases where engines are available for final qualifying tests, costs of such evaluation are extremely high. A 100 hr. lubricant qualification test on a turbojet can cost in the neighborhood of $100,000 and can stretch out for two years. A rule-of-thumb reference to lubrication development time mentioned during the conference was that this generally takes the same time as the engine development.

Air Force, which has the technical responsibility for the U.S. supersonic transport program, is keenly aware of the lubrication problems that lie ahead in this project because of its initial experience on the North American RS-70, General Electric, which is supplying the advanced J93 turbojet for the bomber, also is concerned.

General consensus is that while in the past oil deterioration has been the area of major concern in engine lubricant development, now and in the future engine deposits probably will be the primary concern.

SST Goal

General Electric's D. C. Berkey, pointing out that the goal for time between engine overhaul for the SST is 2,000 hr., noted that experience with Mil-L-9236B lubricant for the RS-70's J93s indicate that this lubricant's operating life is only 25 hr. before an oil change is required. After 200 hr. of engine operation on this oil change basis, engine face seal coking deposits have built up to a point where they interfere with the seal operation and require dismantling of the engine.

Berkey stated that the supersonic transport probably will require lubricating oils capable of operating at bulk oil temperatures of 400-600F, in order to have a self-contained engine system. Auxiliary cooling devices could possibly be used to maintain oil temperatures at 400F or less, but they add weight and complexity to the system.

He stated that although some improvement is expected in the Mil-L-9236 family of lubricants—which are designed for 400F operation—it is not anticipated that it will meet supersonic transport requirements unless major improvements could be achieved in oxidation stability and production of solid products of decomposition.

Berkey stated that a relaxation of the low-temperature requirement is anticipated in order to achieve higher bulk oil temperatures and improved oxidation stability, since industry feels that a −40F starting capability would be unrealistic for a commercial supersonic transport.

Lubrication requirements for Mach 3.5 and above also are not too well defined, he noted. It is expected that the bulk oil temperature of a typical turbo-ramjet powerplant for this speed regime will be in the range of 500F to 700F while operating as a turbojet. In addition the engine would have to be capable of windmilling in a high ambient temperature. During windmilling, there would be some lubricant heat sink, but the lubricant would be subjected to extremely high local temperatures.

Ether Family

A promising candidate for the high-temperature operating regime is the 5P4E polyphenol ether family, which Aeronautical Systems Div. technicians consider a good lubricant up to 600F or more but is fluid only above 40F.

G. A. Beane, of ASD, indicated that the problem appears to come down to development of lubricants capable of operating in the 20F to −40F range and at bulk oil temperatures of 500F.

ASD would like to receive one or two candidate oils from each research organization willing to participate in the program for evaluation and cataloging. ASD's philosophy is not to establish tight requirements on properties such as viscosity, volatility, evaporation, rubber swell, load capacity, flash point and other detail characteristics but to ask only that such candidate lubricants be fluid at zero F or lower, that they be thermally and oxidatively more stable than Mil-L-9236 and that they repre-

Lubrication Problems

San Antonio, Tex.—All aircraft and engines have their share of lubrication problems, USAF Aeronautical Systems Div. representative K. L. Berkey noted at the USAF-sponsored Aerospace Fluids & Lubricants Conference here.

Berkey listed vehicles which have encountered some form of lubrication problem in the past year. Most of these related to the powerplants, but equipment items, which also use engine oil as a lubricant such as constant speeds drives, hydraulic pumps, starters and auxiliary powerplants have also been affected.

Vehicles included the B-47, B-52, C-54, C-119, C-130, C-133, F-100, F-104, GAM-77, H-43B, KC-97, KC-135, T-38, U-3B, U-10 and the X-15. Of these, the B-52H, C-133, F-104, and X-15 encountered serious problems which resulted in numerous mission aborts and even periodic grounding of aircraft, he noted.

sent the lowest deposit-forming experimental lubricant development by the manufacturer at the time they are submitted.

Navy also is preparing for a new synthetic lubricating oil intended for use in growth versions of turboshaft engines and transmissions of next generation helicopters and turboprop-powered fixed wing aircraft which will require oils with higher load-carrying capabilities and fatigue characteristics.

Bureau of Naval Weapons engineer A. Lockwood discussed an experimental lubrication specification, AWS 2994 PP, which is considered past its development stage and will be issued as a military specification later this year.

The new requirement basically calls for a higher viscosity lubricant—5 centistoke at 210F—and an easing of the low-temperature requirement to —40F from the standard —65F. Navy considers this possible since experience has shown that the former standard was not actually necessary, based on operating experience. Lead corrosion limits and rubber swell characteristics are the same as those in current Mil L-7808 specification.

A 200-hr. and a 600-hr. test are under way at Sikorsky on SH-3A helicopter transmissions with a promising candidate in the new specification. A full-scale engine test is being run on an Allison T56-A-3 turboprop at Navy's Aeronautical Laboratory for a 150-hr. period. The latter involves two separate oil systems: one system for the power section operating at an elevated oil inlet temperature of 300F and one system for the gearbox at a normal oil inlet temperature of 180F. Splitting the system into two parts permits separate evaluation of a candidate oil for its oxidation and thermal stability in the power section as it would apply to conventional jet engines and also its load carrying and fatigue-resistant abilities in the reduction gearbox.

Gearbox test results also may be correlated to helicopter transmission performance.

The higher-centistoke oil specification is expected to be returned for some time to come. Future revisions—for the V/STOL aircraft of the 1970 era—probably will require lubricants having higher load-carrying capacity, improved

Lubrication Requirements USAF Weapon Systems

	Present Requirements	Future Anticipated Requirements
Temperature	—300F to 1,500F	—450F to 2,500F
Pressure	Atmosphere to 10⁻⁵ Torr	Atmosphere to 10⁻⁷ Torr
Loads	0—100,000 psi	0—300,000 psi
Speeds	1—10,000 rpm	1—100,000 rpm
Duration	up to 300 hr	up to 30,000 hr

MiG-19 Crashes at Air Show

Soviet built MiG-19 jet fighter of the Indonesian air force crashed recently at an air show in Jakarta after failing to recover from a dive during an aerobatic demonstration. Picture was taken with a telephoto lens a split second before impact. Annual air show was scheduled as a highlight of a visit to Indonesia by Communist China's President Liu Shao Chi, who was the guest of Indonesian President Sukarno.

fatigue characteristics and oxidation and thermal stability. Load-carrying and fatigue properties will be essential for design of lightweight power systems for V/STOL aircraft. The improved oxidation and thermal stability characteristics will be needed to handle the high temperatures that will result from low-altitude, slow and hover flight regimes.

Air Force grease requirements for future space vehicles include need for materials that will withstand ball and roller bearing rotation speeds of 45,000 rpm and a temperature range of —40F to 600F for a minimum of 500 hr without lubrication, John B. Christian of ASD reported. Loads would be on the order of 25 lb radial up to 75% of the rated capacity of the bearing. Advancement of the state of the art to a considerable degree obviously will be needed to develop the future grease lubricants mentioned by Christian for use over the entire temperature range of —100F to 1,000F.

Laboratory studies of experimental greases applied to bearings operating at 600F and 20,000 rpm, reported by P. R. McCarthy, Gulf Research & Development Co., indicate some of the problems facing the user and industry in development of new materials. Best greases available, operating under such conditions, showed a performance life of 150-250 hr. When bearing rotation speeds were advanced to 30,000 rpm, grease life fell off to about 50 hr. At 45,000 rpm, it dropped off to only

RB-57D Marked for Camera Experiment

USAF/Martin RB-57D reconnaissance aircraft has been marked by Minneapolis-Honeywell technicians for use in a company program to improve USAF's aerial photo reconnaissance capability. RB-57D will fly beneath a high accuracy camera mounted in a gondola which is suspended from a balloon at altitudes ranging up to 100,000 ft. Gondola will be reaction jet-stabilized. Photos of the test patterns and mirrors, visible as convex bumps on the wings and fuselage, will be studied to define camera-confusing effects of air turbulence.

20 hr. These tests indicate that 500-hr. minimum life at 600F and 20,000 rpm will require considerable research and time to achieve. Target 500 hr. life at 600F and speeds of 30,000 rpm - 45,000 rpm seems to be out of range, McCarthy indicated. Research in these materials has just scratched the surface, he said.

The overall capabilities of hydraulic fluids for use in aerospace vehicles and support equipment will require major expansion to meet forthcoming needs, Aeronautical Systems Div. technicians reported. High temperature capabilities should be increased to 700F, while maintaining good properties at −30F, good lubricity and better fire-resistant qualities than today's fluids. As a measure of what these parameters mean, Monsanto Research Corp. spokesmen point out that fire-resistant fluids now used are not thermally stable above 225F and cannot be used in the 400F environment predicted for the supersonic transport.

The polyphenol ethers appear to offer the best thermal and oxidative stability of currently available formulations. They show a capability of operating up to about 850F, but their low-temperature qualities leave something to be desired, with pour points ranging from zero to 60F. Deep dewaxed mineral oils and synthetic hydrocarbons also have some promise, with indications of an ultimate temperature range capability of −65F to 700F.

Details of some of the malfunction problems described by Berkey as typical examples were:

■ Douglas C-133's P&W T34 turboprop engine has encountered what he termed serious reduction gear problems, a number of in-flight failures having occurred involving virtual nose section disintegration. Pratt & Whitney contended that the Mil-L-7808 oil was too low on load-carrying ability (LCA) for the T34 engine and recommended three older blends having a higher LCA. In view of the fact that these engines had their power ratings increased to 6,500 shp. and 6,950 shp. from the earlier designed rating of 5,500 shp., this recommendation was considered valid. Accordingly, San Antonio Air Materiel Area (SAAMA) which has engineering responsibility for the T34, adopted P&W's comments, has procured one of the three oils recommended, and along with modifications to the nose section, is receiving satisfactory service from the powerplants.

Since the C-133 operates from only two bases, the SAAMA decision to use the selective oil was not objected to by ASD since no logistics problems are involved, but this practice is normally discouraged on aircraft which operate from numerous stations.

ASD is investigating the possibility

How can research lead to improved ground warfare preparedness?

Battlefield of the future will be patrolled by passive influence fuzes that will trigger warheads by sensing specific circumstances such as (1) the pressure signatures of personnel entering the area, (2) the sound pattern or infrared radiated by a vehicle, and (3) disturbances of ambient magnetic fields by vehicles or personnel.

New weapons system concepts will result from government-industry advanced R&D

U S Army plans call for a significant modernization program during the next decade. The fiscal '64 Army budget proposed a substantial increase for research, development and procurement. If approved, this will make it possible for the Army to step up its pace in modernizing its ground warfare techniques and equipment.

Improvements in Army mobility, close air support of combat units, target tracking, stabilization and fire control, communications, command and control—all of these and others will result from the research and development effort.

A number of these new system concepts are now being studied by R&D groups at Honeywell (see examples below). Under funding from government agencies and our own independent development funds, Honeywell is investigating advanced concepts in the areas of missile systems, fuzing, warheads, guns, artillery, mines, bombs, stabilization and fire control, surveillance, communications and data handling, and training and simulation.

These programs are an indication of how the capabilities of industry can assist government laboratories and agencies in their activities toward improving the Army's combat effectiveness.

For more information on our research, experience and capabilities in ground warfare technology, write Honeywell, Dept. 671-K, Minneapolis 40, Minnesota.

Operations analysis conserves R&D funding

Due to increased costs in developing ground weaponry, Honeywell has established an operations analysis capability that analyzes all facets of a weapon system design during the pre-development and development stages. This capability enables government agencies and Honeywell researchers to conserve R&D funds by determining the weapon systems needed, what their performance should be and how they can be used to best advantage.

Three major aspects of operations analysis are stressed at Honeywell:

1. REQUIREMENTS ANALYSIS determines which areas require new or improved weapons. Intelligence on enemy force structure, equipment, strategy and tactics is analyzed and recommendations for improvements or new weaponry made.

2. SYSTEMS OPERATIONS provides data on development and how the system is to be used. For example, target analyses identify tactical situations and define target types. Target vulnerability is defined. System cost and cost-effectiveness and weapon system vulnerability and/or survivability are also determined.

3. WEAPONS ANALYSIS establishes optimum values of design parameters on the basis of maximum system effectiveness. During the initial phase of a development program, for example, mathematical models for evaluating warhead and system effects are established and programmed. Working closely with design engineers, weapons analysis personnel evaluate a warhead and its components to determine effect on total system performance. Parametric studies are conducted to establish design trade-offs and to determine optimum system performance characteristics.

Future tanks will fire accurately while moving

The moment a tank stops to zero-in on a target, it may become vulnerable to enemy attack. This liability may be reduced by a new system being developed at Honeywell for the Army Tank Automotive Center. Currently in breadboard form, the Target Referenced Tank Gun Control System will allow a tank gunner to very accurately hold his gun sight on a *stationary* target while the tank is in motion. The tank gun is kept zeroed-in on the target by the use of gyros, accelerometers and an analog computer which provide the pitch, yaw and translations of the tank gun during the maneuvers. This information is used to automatically and continuously re-direct the gun and turret to the target. In addition, Honeywell is studying automatic tracking of a *moving* target by a moving tank.

Mathematics breakthrough leads to inertial fuze

An inertial fuze, several times more accurate than any other inertial fuze, has been devised by Honeywell for pinpoint detonation of a missile warhead. Less complex than a radar fuze, it is practically unaffected by vehicle and trajectory variations or atmospheric perturbations.

The Honeywell fuze, portions of which are currently in breadboard form, can be made virtually insensitive to nuclear radiation. Since it operates by sensing changes in the density of the atmosphere, it can be used on any warhead having a sufficiently high re-entry altitude.

The design of the inertial fuze was facilitated through the use of the adjoint analysis technique—a mathematical concept fashioned by Honeywell for use as an evaluation and design synthesis tool.

Needed was a combination of efficient and accurate simulation of a ballistic missile and its trajectory, the adjoint program was the breakthrough that produced such an evaluation in six degrees of freedom on a single computer run.

Laser range finder being developed by Honeywell under a company sponsored program will be mounted inside a tank as shown in this artist's conception. The pulsed ruby laser will be considerably smaller than present optical range finders.

Laser evolving as ranging device

Honeywell is developing a laser range finder for tank fire control and helicopter weapon systems. While similar to radar, the laser system has a beam less detectable by the enemy. It also reduces background clutter that often complicates battlefield ranging problems.

Both gaseous and solid state approaches are being studied, aiming at a range of at least 5,000 meters, data rate of ten bits per second and a total weight of 15 pounds. All of the engineering resources for development of such a laser are available at Honeywell.

Honeywell is also investigating improved laser materials, advanced techniques of pumping, possibilities of operating in new parts of the spectrum, and higher power in pulsed and continuous wave lasers.

Honeywell

ENGINEERS AND SCIENTISTS: Explore new professional opportunities. Write Mr. Fred L. Laing, Honeywell, Minneapolis 8, Minnesota.

U.S. Navy Evaluates Australian Target System

U S Navy Missile Center, Pt Mugu, Calif., is conducting a second series of evaluation flights with the Australian-built Jindivik jet-powered target aircraft Current program of 20 flights will provide targets for Pacific Fleet ships on the Pacific Missile Range Specially configured Jindivik systems are being used as targets for fleet surface-to-air missiles Australian system is 23 ft long with a wing span of 25 ft 7 in and is radio-controlled Speed capability is near Mach 1, and the system can operate above 60,000 ft

of using the newly developed Navy XWS 2994 PP lubricant for possible use in the T34 because of its LCA and higher viscosity

• **Lockheed C-130's Allison T56** turboprop engine, Berkey reported is in the midst of an oil coking and sludging problem resulting in oil jet and screen plugging, oil seal failures and other component problems Oklahoma City Air Materiel Area, which has engineering responsibility for the T56, in conjunction with Allison, has made several modifications in screens, seals, operating and maintenance procedures without too much success, Berkey reported He noted that this appeared to be another case where difficulties may have been engendered by increasing the engine power rating from 3,750 to 4,000 shp last year

No information has been made available to ASD to indicate that temperature profiles have been accomplished on the uprated power section to determine the locations of critical hot spots

Until this is done, ASD believes that the problem will not be solved and it is very questionable that modifications to seals, screens and other engine components will provide enough of a "crutch" to sufficiently ease the problem Berkey stated

• **Boeing B-52H Sundstrand** constant-speed drive is having problems of oil coking and sludging, according to Berkey This unit uses Mil L-7808 oil One design change in the oil system provided for additional cooling of the oil in later B-52Hs delivered to bases in Florida and in South Dakota These aircraft initially had consistently better reliability than earlier aircraft not having the new coolers But with the advent of winter, the Northern B-52H base re encountered the initial problem, while the Florida base did not The engine-driven drive in turn drives a 120 kva alternator Each airplane has four of these packages The South Dakota base experimented with their training aircraft by allowing a 10-min warmup period after engine start before application of any appreciable loads to the alternator which showed improvement in reliability

With the SAC operational commitments, the alert aircraft do not have 10 min for warmup purposes, Berkey noted ASD is initiating a test program with closely controlled and instrumented CSD's to attempt to define the problem

SAC has also requested that the CSD manufacturer's contention that different brands of 7808 oil should not be mixed in individual drives be investigated

OCAMA, Middletown AMA, SAC and ASD are establishing a service test at one B-52H base to generate operational information on mixing

A-6A Computer

Giannini Controls Corp will build central air data computers for Navy's A-6A Intruder aircraft under a $1,100,000 contract from Grumman Aircraft Engineering Corp

'Eyeball' Exercise Set For Detection Methods

Washington—Long-range program to field test military detection, inspection, and surveillance methods will be launched this spring with a game testing the capability of ground personnel to distinguish equipment at fixed locations by "eyeball" inspection

The program, known as Project Cloud Gap, is a joint venture of Defense Dept and the Arms Control and Disarmament Agency

The first gaming exercise will be held at a large Army installation, such as Ft Knox, Ky or Ft Hood, Tex

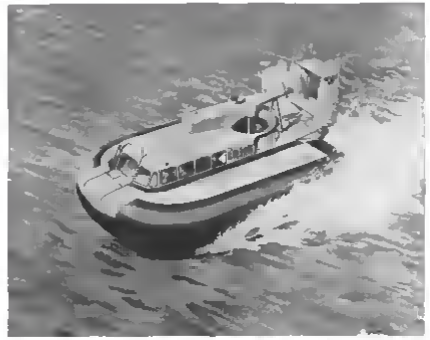
This will be followed, probably in the early summer, by a sophisticated exercise in which the targets of inspection will be mobile equipment and the ground "eyeball" inspectors will be aided in the exercise by inspection from helicopters

These other projects are in the early planning stages

• **Field test** to determine the capability of sensor equipment such as radars and infrared devices

• **Small-scale prototype test** to determine the capability of an integrated inspection using ground and air methods and devices and data processing

Dr Lessing Kahn, a military systems analyst with ACDA, is project manager of Cloud Cap Deputy project manager is Brig. Gen. Edwin S. Chickering a career Air Force officer with extensive operational background



WESTLAND SRN-5 HOVERCRAFT, above left, will carry up to 20 passengers or two tons of freight over rough country, cruising at 70 kt. An advanced version will carry up to 150 passengers. Design and engineering studies are under way for eventual construction of the Westland SRN 4, a 600-passenger, cross-Channel Hovercraft, above right

Westland to Build SRN-5; Gnome To Be Standard Hovercraft Engine

London—Westland Aircraft, Ltd., Great Britain's only helicopter manufacturer, last week said it would extend its Hovercraft family by building a 20-passenger SRN 5 model and standardize on the Bristol Siddeley Gnome turbine engine for the entire range.

Decision to build the SRN 5 followed successful testing of long rubberized fabric skirts to contain the air cushion, according to Sir Eric Mensforth, Westland chairman.

Deliveries of the newest model can be made by March, 1964, and Westland's Saunders-Roe Division is now tooling for a production batch at its Cowes plant.

In other Hovercraft developments:

• **Ministry of Aviation** has ordered a SRN 3 Hovercraft for a joint services trials unit at Lee-on-Solent. The SRN-3, the military version of the SRN 2 (AW July 9, p. 56), will be fitted with the long skirts.

• **Mark 2 version** of the SRN 2, carrying up to 150 passengers, is now under construction at Cowes. Powerplants are four 885 shp. Gnomes. Hull has been stretched 10 ft. 6 in. for an overall length of 77 ft. and beam of 30 ft. 6 in.

• **Design work** on a 600-passenger SRN 4, aimed primarily at English Channel traffic, is well advanced. Mensforth claims that 10 of these vehicles would handle all traffic envisioned for a Channel tunnel by 1970.

The SRN-2, which starts demonstrations on the St. Lawrence River May 2, will cost $929,000. Price of the Mark 2 version is $1.3 million and the SRN 5 will cost $228,000. Mensforth said price of the cross-Channel ferry has not yet been determined by the manufacturer.

Tooling capacity is based on a production line of 20 vehicles per year. Aside from the Ministry contract, no orders have yet been received, although Westland has signed a license agreement with Mitsubishi Shipbuilding & Engineering Co. of Tokyo.

The SRN-5, now in an advanced stage of construction at Cowes, is primarily designed for rough country operations. Powerplant is a single Gnome and gross weight is 14,000 lb. The vehicle is 38 ft. long, with a 22 ft. 5 in. beam, and will cruise at 70 kt. It will be fitted with 4 ft. skirts.

So far, Westland has invested about $6 million of company funds in Hovercraft development work, according to Mensforth. He said direct operating costs, based on the Society of British Aircraft Constructors formula, work out to about five cents a mile for the SRN-2, about four cents a mile for the Mark 2 version, and five cents a mile for the SRN 5.

AFOSR Awards

Air Force Office of Scientific Research recently awarded grants and contracts for more than $3.5 million to universities and research firms in the United States and Europe.

Grants:

University of California (Berkeley, Calif.)—$10,599 for study of biocontrol systems; $25,400 to study partial differential equations; $215,506 to investigate electronic structure of metals; $9,120 for research on verbal learning and verbal behavior; $1a-000 to study three-dimensional problems of supersonic and hypersonic flow and panel flutter of cylindrical shells.

Rensselaer Polytechnic Institute (Troy, New York)—$49,970 to investigate variable interval repetitive prediction of stochastic signals.

University of Oklahoma Research Institute, (Norman, Okla.)—$16,206 for determination of orbital excitation cross sections in atomic collisions.

Case Institute of Technology (Cleveland, Ohio)—$24,742 to investigate order statistics and non-parametric analysis.

University of Minnesota (Minneapolis, Minn.)—$32,052 to investigate transport and transformation in continua; $146,400 for point defect studies in group 2-6 compounds.

Assumption College (University of Windsor, Windsor, Ont., Canada)—$57,196 to investigate optical pumping in alkali metal vapors.

Vanderbilt University (Nashville, Tenn.)—$26,850 for experiments on plasma structure.

University of Western Ontario (London, Ont., Canada)—$37,985 to investigate millimeter and submillimeter EM radiation produced by high energy electron beams.

University of Alabama (Tuscaloosa, Ala.)—$33,540 to investigate submillimeter radiation from relativistic electrons; $89,616 for studies of solids at low temperatures.

University of Illinois (Urbana, Ill.)—$67,485 for studies in quantum and solid state electronics.

Yale University (New Haven, Conn.)—$278,000 for studies of the properties of atomic molecules and plasmas by the methods of radio-frequency, microwave and optical spectroscopy; $33,133 to investigate pressure dependence of electrolytic conductance.

University of Rochester, (Rochester, N. Y.)—$337,008 for basic research in optics; $77,216 for theoretical studies of effects of coherence in electromagnetic radiation.

Cornell University, (Ithaca, N. Y.)—$67,915 for study of detection of high energy cosmic photons.

Purdue Research Foundation (Lafayette, Ind.)—$26,250 for the theoretical study of nuclear structure and reactions.

Battelle Memorial Institute (Columbus, Ohio)—$80,184 to study magnetic susceptibility and shielding constants in solids; $68,980 for fundamental studies of diffusion; $67,440 to study pressure effects on charge transport phenomena in metal oxides.

Virginia Institute for Scientific Research (Richmond, Va.)—$84,085 to study growth and perfection of single crystals of the alkali metals, the rare earths, cobalt and solid solution alloys.

Brown University (Providence, R. I.)—$106,220 for ultrasonic study of electronic motion in metals.

University of New York (Albany, N. Y.)—$16,466 to investigate stable and unstable allyl and germyl compounds; $14,266 for investigation of dielectric constant of hydrogen bonded liquids.

Oregon State University (Corvallis, Ore.)—$34,911 for investigations of the structure

and dynamics of molecules by electron diffraction.

Indiana University, Bloomington, Ind.—$84,840 for electronic computer calculations on simple polyatomic molecules.

University of Colorado, Boulder, Colo.—$58,730 for NMR studies of intra- and intermolecular interactions.

University of New Mexico, Albuquerque, N. M.—$87,380 for fundamental investigations of lanthanoid molecules.

Ohio State University, Columbus, Ohio—$61,800 to study molecular structure of carbenes and the kinetics of their exchange process in solution.

University of Washington, Seattle, Wash.—$9,280 for study of the chemical bond through the Mossbauer effect.

University of Massachusetts, Amherst, Mass.—$28,300 to investigate rates of exchange of solvent molecules with paramagnetic ions.

Florida State University, Tallahassee, Fla.—$20,724 for study of factors controlling protein synthesis.

University of Texas, Austin, Tex.—$10,515 for research on arousal, management and reduction of hostility; $41,174 for investigation of physics of metastable systems.

University of Pittsburgh, Pittsburgh, Pa.—$38,592 for studies in acculturation as factors in persuasion analysis.

Princeton University, Princeton, N. J.—$8,800 to investigate learning concepts and rules.

Washington State University, Pullman, Wash.—$10,344 for investigation of short-term memory in a sequential task.

Johns Hopkins University, Baltimore, Md.—$18,000 to investigate turbulent shear flows.

Massachusetts Institute of Technology, Cambridge, Mass.—$14,630 to study random vibrations in aerostructures; $28,440 for study of conduction in ionized gas-surface interactions.

University of Toronto, Toronto, Canada—$21,737 to investigate transfer of mass, momentum and energy in free molecule systems.

University of California, Los Angeles, Calif.—$18,868 to study high temperature chemical kinetics.

Contracts

Westinghouse Electric, Baltimore, Md.—$37,997 for analytical solutions to problems in celestial mechanics.

General Electric Co., Phoenix, Ariz.—$19,126 for research in theory of machines.

Radio Corp. of America, Princeton, N. J.—$137,081 to study growth of properties of single crystals of non-metallic magnetic materials.

United States Industrial Chemicals Co., Cincinnati, Ohio—$53,924 to study hydrogen transfer reactions in catalytic homogeneous systems.

Serendipity Associates, Los Angeles, Calif.—$25,196 to investigate military groups under stress; the role of the VIP.

Giannini Controls Corporation, Beewyn, Pa.—$49,944 for advanced gyroscopic systems studies; $30,086 to study internal aerodynamics of spinning flows.

Flight Sciences Laboratory, Buffalo, N. Y.—$28,468 for investigation of simulation of hypervelocity aerophysical phenomena.

North American Aviation, Canoga Park, Calif.—$40,841 for research on properties of high current, low-frequency thermoless discharges in moderate pressure gases.

Armour Research Foundation, Chicago, Ill.—$42,587 for study of vibrational relaxation of some diatomic gases.

Atlantic Research Corporation, Alexandria, Va.—$43,950 to investigate hydrogen-fluorine reaction.

Thiokol Chemical Corporation, Denville, N. J.—$53,375 to study acceleration of heavy particles.

General Applied Science Laboratory, Inc., Westbury, N. Y.—$89,722 to study hypersonic combustion.

Space Technology Laboratory, Inc., Redondo Beach, Calif.—$52,843 for research in properties of accelerated plasmas.

Smithsonian Institute, Washington, D. C.—$18,600 for basic research research vol. 4.

European Grants

University Libre de Bruxelles, Brussels,

Belgium—$28,000 to study the theory of the many body problem.

University College, Dublin, Ireland—$11,500 to investigate Cerenkov light from extensive air showers.

University of Naples, Naples, Italy—$16,000 to study structure and function of nerve nets.

The Weizmann Institute of Science, Rehoveth, Israel—$20,000 to study biologic significance of high molecular weight polypeptides.

Hebrew University, Jerusalem, Israel—$25,040 to study role behavior and social structure.

University of Oxford, Oxford, England—$20,000 for study of cognitive and affective attitudes.

Technion Research & Development Foundation Limited, Haifa, Israel—$40,194 to investigate the buckling of stiffened and unstiffened conical shells under axial compression and combined loading.

Training Center for Experimental Aerodynamics, Brussels, Belgium—$22,500 for AGARD-TCEA post graduate fellowship award.

Contract:

Hebrew University, Jerusalem, Israel—$30,000 to study electron density ionization rate and approach to thermal equilibrium behind shock waves.

Advanced Engineering Center Set for MIT

New York—Center for Advanced Engineering Study will be established at Massachusetts Institute of Technology, Cambridge, Mass., under an initial grant of $5 million from the Alfred P. Sloan Foundation here.

Purpose of the center is to provide advanced education for engineers and engineering professors in the new sciences that form the basis for much of contemporary engineering.

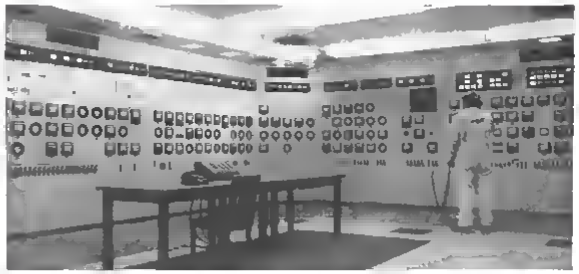
Courses at the new center will range from one- and two-week studies in specialized fields to one-year courses in much greater breadth and depth of subject matter.

Basic need for the center stemmed from the explosive growth of technology in almost every field and the shortage of engineers and professors to work and teach in these new problem areas. Long-term solution for this need requires that the capacity of engineering graduate schools be doubled. It also demands that the engineer in management be as conversant with advanced technology as he is with management techniques.

Courses paralleling this thinking have been offered in the past at MIT and other educational institutions, but at none of these institutions has there been a centralization of this effort into an on-campus, resident academic program.

Funding by the grant is intended to cover construction of a new building on the MIT campus at Cambridge, Mass., and the first five years of center operations.

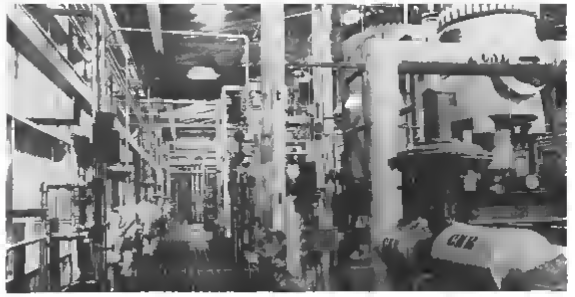
Building cost is estimated at $2.7 million.



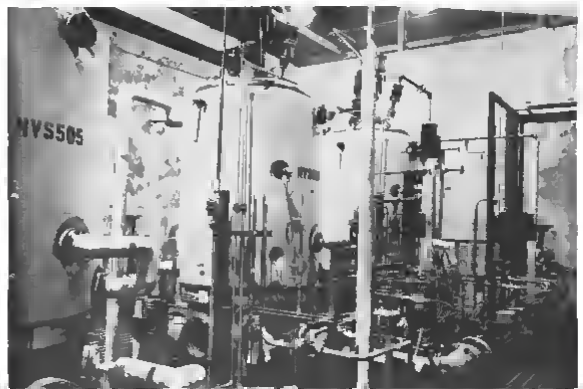
MASTER CONTROL ROOM of new nitroplasticizer plant monitors continuous production

Continuous Process in Polaris Propellant

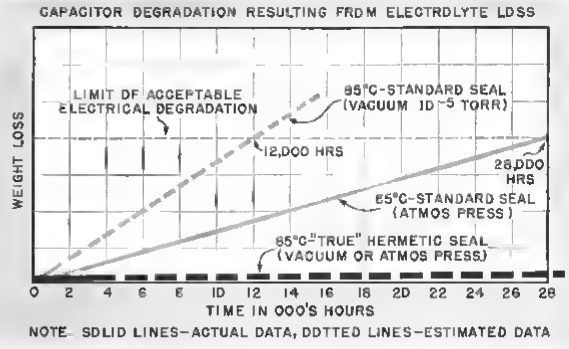
Sacramento—Continuous-process technique for producing high-energy liquid mix in the form of nitroplasticizers for the solid-propellant first stage of the Polaris A-3 has been developed by Aerojet-General Corp. here. Company recently activated a $4.6-million facility to produce the liquid mix on a continuous basis. Nitroplasticizers are a mixture of *bis* (2,2-dinitropropyl) formal and *bis* (2,2-dinitropropyl) acetal. Aerojet says the mixture has a higher specific impulse which is, in part, responsible for the 2,500 nautical mile range of the A-3, and the propellant has minimum shrinkage during room temperature curing, which results in less cracking and separation from the case. Cost is estimated to be about two-thirds that of the batch mix process.



MAIN PROCESS AREA (above) of the new Aerojet plant continually mixes nitroplasticizer, high-vacuum distillation area (below) purifies end product.



Accent on VALUE



New hermetic seal... new capacitor life

Now, to the inherent advantages of foil tantalum capacitors, General Electric adds a true hermetic seal It employs a spacial glass which is bonded to tantalum oxide by a receotly parfected process

As shown above, this new seal increases the life of foil capacitors by virtually abminating electrolyte loss Combined with the high-voltage, high-microfarad, and self-healing characteristics of foil capacitors, this *added* life makes G-E foil Tantalytic* units extremely well suited for use in missiles, satellites and other electronic aystems where high reliability is required.

Outstanding advantage of the glass seal over a seal of organic material is that glass will not out-gas when exposed to vacuum or radiation. Glass is more stable to the chemical actioo of electrolyte, too. Both features reduce the possibility of contaminating vapors entering surrounding equipments, and improve capacitor reliability

In developing the hermetic seal, General Electric has had the support of North American Aviation's Autonetics Division as a part of the program to develop High Reliability capacitors for the Air Force Minuteman More recently, US Army Electronics R&D Laboratory awarded G E a contract to support development of a hermetic seal for standard foil capacitors.

Ratings of the new hermetically sealed capacitors are 85 C and 125 C, 15 to 150 volts, and 75 to 610 microfarads. They come in 3 case sizes, of polar and nonpolar construction.

Ask your General Electric Sales Engineer about the units now available from stock for prototype work He'll be happy to assist you with application, too For more information, write for Bulletin GEA-7614, to Section 430-16, General Electric Co., Schenectady, N Y *Electronic Specialty Capacitor Product Section, Irmo, S C.*

* Reg trade mark of General Electric Co

Progress Is Our Most Important Product

GENERAL ELECTRIC

New Type Radar Probing Surface of Moon

By Philip J. Klass

Washington—First radar reflections from the lunar surface obtained at a frequency of 35,000 mc., more than four times that of previous radar probes, suggest that the moon's surface is fairly rough with respect to the dimensions of the 8.6-mm. waves employed.

Preliminary results of the first lunar contact with the new Lincoln Laboratory high-resolution radar telescope, achieved in early April, were reported here at the 44th annual meeting of the American Geophysical Union by Vernon L. Lynn. The report was jointly authored with M. D. Sohigian and E. A. Crocker also of Lincoln Laboratory.

The new 8.6-mm. equipment, using a 28-ft.-dia. precision antenna, achieves a beamwidth of only 4.3 mm. of arc, corresponding to an area roughly 250 mi. across on the lunar surface.

In addition to the advantage of being able to view a smaller area than previously possible, the new radar telescope will provide data on the absorption and reflection characteristics of the lunar surface at a new wavelength, offering additional clues to its composition and roughness.

New Lincoln Laboratory radar telescope operates at the same wavelength as the radiometer being used by Ewen Knight Corp. to measure passive microwave radiation from the lunar surface. This offers the intriguing possibility of correlating data from the two experiments for complementary determinations, Lynn said.

In the Ewen-Knight experiments, microwave radiation from the lunar surface is being measured as areas pass from being illuminated to the dark phase (called "phase-lag cooling") to determine how quickly the surface cools. This provides data on surface conductivity and emissivity, an indication of its composition and granularity, which then can be correlated with data from the radar telescope.

While Lynn emphasized that data obtained so far is very tentative, he said it showed no significant difference in reflected radar energy when the antenna was aimed at mountains and lunar maria. The diffuse scattering experienced at 8.6 mm. "appears to be somewhat greater than that obtained at lower frequencies," he noted. This suggests that compared with the dimensions of the 8.6 mm. wave (roughly one-third inch long), the lunar surface is relatively rough. Previous measurements at 36 mm. (roughly 1½ in.), which yielded more energy reflected back to the antenna, suggest a smoother surface with respect to the dimensions of the wave.

Data obtained in limited tests show that the moon's effective radar cross-section at 8.6 mm. is about 3.5% of what it would be if it were a solid metal sphere.

This compares with an effective cross-section of about 4% at 36 mm. wavelength, Lynn reported.

The new Lincoln Laboratory radar telescope is relatively low-powered with a peak output of 12 watts. It transmits a pulse of 15 seconds duration which is followed by a 15 second reception interval. But the effective transmitted pulse is only 2½ sec. long since the echos from the first 12½ sec. of the transmission returns from the moon while the transmitter is still operating. The system does not provide for any range resolution, a technique employed by earlier broad-beam radar telescopes to achieve improved area resolution.

The receiver contains 10 parallel channels each with an intermediate frequency bandwidth of 170 cps. and spaced 100 cps. apart. To compensate for velocity of the moon relative to the earth which introduces a Doppler shift in the returned signal, a continuous Doppler correction is provided so that the echo falls in the center channel. Because of spectrum smearing caused by moon vibration, the deviation in frequency between the transmitter and the local oscillator must be held to three parts in one billion during the 2½-sec. interval required for the signal to return from the moon.

The Lincoln Laboratory radar telescope uses a conventional receiver with a noise figure of about 10.9 db. Because of this and the modest transmitter power level, video integration with a 2½ sec. time constant is employed, corresponding to the 2½ sec. "effective" transmitted pulse duration.

The 28-ft. antenna, built by the Kennedy Antenna Division of Electromechanical Specialty Co., carries an optical telescope that is accurately boresighted to the antenna's radiation axis to enable scientists to determine antenna aiming point on the lunar surface. The antenna dish was fabricated to required 35,000 mc. tolerances by the Spincasting process. It is the largest precision paraboloid reflector ever fabricated in a single piece, according to the manufacturer.

HIGH-RESOLUTION RADAR TELESCOPE, first to operate at 8.6 mm. wavelength, is being used by Lincoln Laboratory to probe lunar surface. First returns suggest that lunar surface is relatively coarse with respect to one-third inch dimensions of waves used.

Laser Discovery

Discovery of an unusual type of motion in atoms within a crystal by scientists of the Westinghouse Research Laboratories is expected to help raise the maximum operating temperatures of lasers and masers, permitting high output powers, and may lead to a solid-state rate gyroscope using spinning electrons.

Westinghouse scientists discovered that a few atoms located at discontinuities—defects—within the crystal structure experience an acoustic vibration instead of vibrating coherently with other atoms within the crystal. The new theory may explain the previously unexplained effect of neutron radiation on fused quartz crystals.

In experiments, company scientists were able to maintain electron spins in an inverted position for periods of several hours, which suggests the feasibility of using them as a rate gyro. A quartz crystal immersed in liquid helium at a temperature of 4.2K was enclosed by a superconducting magnet. The electrons were inverted by stimulating them with radio frequency energy at 9,000 mc. As the electrons slowly flip back to their original position, they cause crystal defect atoms to vibrate.

FILTER CENTER

► **Laser Gyro Advance Reported**—Sperry has improved the sensitivity of its laser gyro to where it can now measure rotations as slow as 1.2 deg. per minute, nearly half the minimum rate achieved three months ago (AW Feb. 11, p. 93). Company also has isolated three major problem areas which tend to limit laser gyro sensitivity and currently is working on techniques for overcoming them. Dr. George R. White told the National Academy of Sciences. These should enable such devices to provide drift rates better than 0.1 deg./hr., but White expressed doubts whether the laser gyro could hope to match the 0.001 deg./hr. drift rate of floated gyros used in inertial systems. Current laser gyro problems include interaction between two contra-rotating laser beams, sensitivity to external vibration and multiple-mode noise due to transverse radiation modes within the laser. White said that Sperry plans to polarize the laser beams and use Faraday rotators to prevent the interaction between the two beams.

► **BTL Extends Laser Spectrum**—Laser emission at 34.5 microns, approximately 6.5 microns further into the far-infrared region than previously reported, has been achieved by Bell Telephone Laboratories using a noble-gas neon device,

BTL's Dr. C. G. B. Garrett revealed during the recent meeting of the National Academy of Sciences. Gas lasers now cover roughly half the spectrum between the visible light and millimeter microwave region where conventional sources are available, Garrett said. Dr. Robert Hall, General Electric Research Laboratory, predicted that emission from direct injection gallium-arsenide lasers would be expanded from present 0.84 micron (near infrared) to 10 microns and possibly beyond using other types of direct-transition semiconductor materials. But he was less optimistic about the possibility of obtaining shorter wavelength radiation.

▶ **High Power Laser Prediction**—Dr. Charles H. Townes, co-discoverer of the laser, predicted that "we can look forward to traveling-wave type ruby lasers with peak power levels of a million megawatts with pulse durations of about 0.01 nanoseconds (billionths of a second)." If lasers capable of generating kilowatt power levels on a continuous basis can be developed, it may be feasible to use such devices to transmit electric power to satellites, he said.

▶ **Gallium Cell Damage Explained**—Sharp drop-off in short-circuit current of an unshielded gallium-arsenide solar cell carried by Relay communication satellite does not mean that the new material is not living up to its predicted radiation resistance, according to its supporters. After 100 days in orbit which took the satellite through the most intense electron and proton belt produced by the July 9 Starfish nuclear test, the completely unshielded gallium-arsenide cell's short-circuit current had dropped to 13% of its original value while unshielded silicon cells were degraded only to about 24% of original value. Proponents of gallium arsenide cells point out that radiation damage has more adverse effect on gallium arsenide's short-circuit current than on that of silicon cells, but that reverse is true for their open-circuit voltages. A more realistic appraisal of relative radiation resistance requires that cells be loaded for maximum power and that all cells be provided with suitable protective shields, proponents say.

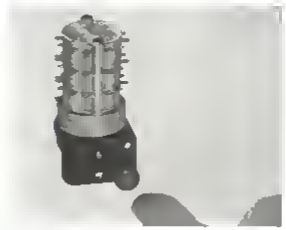
▶ **Sylvania Developing Miniature Rescue Beacon**—Progress report on the development of a miniature two-way rescue radio set and beacon was presented recently at the Navy's Microcircuitry Conference in Washington. Sylvania is developing the AN/PRCXN-1 rescue set (AW July 9, p. 46) under a $190,000 contract from the Bureau of Weapons. Using thin-film microcircuits, it fits into pocket of pilot's flight suit and automatically sends a signal on a distress band when parachute opens.

NEW AVIONIC PRODUCTS

• **Tweezer welder** with fingertip control, for use with any spot welding machine suitable for bonding electronic components, permits setting of tweezer pres-

sure at which discharge occurs to eliminate need for foot switch and ensure two parts are under sufficient pressure before welding Manufacturer: Lincoln Instrument Co , 2414 So Broadway, Santa Ana, Calif.

• **Push-button rotary switch**, 12-position, Series 2114, combines circuit switching features of conventional rotary switch with push-button operation Window on mounting bracket provides digital indication of switch position



Device is totally enclosed and exceeds requirements of MIL-S-6807A and MIL-S-3786A, according to manufacturer Contacts can handle up to 5 amp at 115 v a c and 3 amp at 28 v d c resistive or 2 amp inductive Manufacturer: Janco Corp , 3111 Winona Ave , Burbank, Calif.

• **Gas-filled laser tube**, Model LT-40, contains mixture of 0.9 mm of helium and 0.09 mm of neon which will radiate at 6,328 or 11,530 Angstroms with suitable mirrors and radio-frequency excitation Tubes are made of quartz and are supplied with quartz windows at the Brewster angle Inside diameter is ¼ in and length is 40 in Manufacturer: Lattoo Industries, Electron Tube Div., San Carlos, Calif.

Value Engineers' Proper Role Discussed

By Donald E. Fink

New York—Value engineers were told they have a role in the Defense Dept.'s current cost-reduction program at their recent Society of American Value Engineers convention here, but they also heard a frank warning against overmagnifying the importance of their programs.

George E. Fouch, deputy assistant secretary of defense, told the group that the military services will sponsor and support value engineering programs, because they cannot acquire the hardware they need unless they make their dollars go farther.

Barry J. Shillito, president of the Logistics Management Institute, acknowledged this need for value engineering, but pointed out that value engineering programs will contribute only if they are well defined, logically developed and properly applied. His speech served to counterbalance Fouch's by admitting that value engineering programs are important, but that they have their potential problem areas.

Fouch said value engineering cost-reduction goals have been established by DOD as part of the cost reduction program.

"These goals are $64 million for Fiscal 1963 and $100 million for Fiscal 1964 and 1965," he said. "The services and defense agencies are distributing these goals to lower echelons."

Fouch added that contractors will be motivated to adopt value engineering because it invites them to challenge government requirements, which industry often has considered unrealistic, and to profit by doing so.

He described value engineering as a technological movement which recognizes the need for reducing costs and eliminating wastes and which uses systematic technical disciplines to achieve these goals.

The objectives will be realized by rigorous analysis of design, production methods, testing procedures and related activities, to separate useful requirements and practices from the useless, he said. Value engineering is a management technique that has economic meaning and should not be treated as a technical exercise irrelevant to primary management objectives, Fouch noted.

He added that DOD is implementing a three phase program to encourage value engineering programs in industry.

• **Formulation of incentives** to encourage accelerated use of value engineering.

• **Development of concepts** and techniques that industry can use to improve value engineering as a management and procedural tool.

• **Institution of a program** to keep industry informed of the latest value engineering objectives and methods.

The progress of value engineering, like many other disciplines, is dependent on its effective implementation, Fouch said. A determined effort is needed now to strip down DOD procurement requirements to the essentials and to reward authentic performance. Value engineering is one means to that end, he added.

Shillito, whose company has prepared a value engineering handbook which DOD will use in its cost-reduction program, said sample studies made during its preparation pointed up potential problem areas in value engineering programs.

He said value engineers should guard against overstating their capabilities or burdening their programs by trying to assume tasks from other, unrelated functions.

Shillito made these specific points:

• **Value engineering** is not a science, nor is it a separate technology. Value engineers must have a sound technical background, but do not necessarily need to be technical specialists.

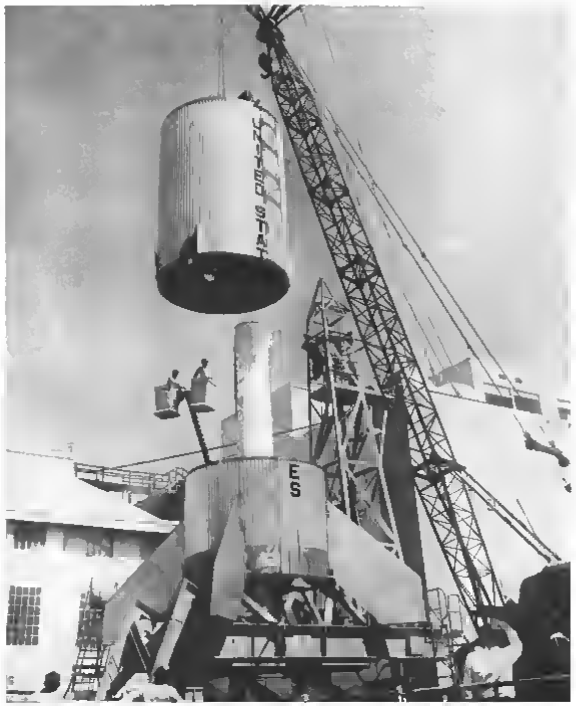
• **Managers of value engineering** programs do not necessarily have to report directly to top management levels. If a value engineering program is functioning properly, it will have an impact on a company's financial status and will gravitate naturally to its proper place in the management structure. Position of the program in the management chain will depend upon its contribution to the company.

• **Value engineering** programs must concentrate on functional cost reductions of hardware and should not attempt to embrace all types of cost effectiveness or work study programs. Efforts to reduce clerical or computer program costs, for example, should be left to the sections directly involved.

• **Value engineers have not** applied their efforts selectively or analytically in the past. Sample studies revealed that most value engineering projects were selected haphazardly. To insure success of value engineering, a systematic method of applying its resources must be followed.

Shillito said U.S. survival depends upon its ability to wage all types of war ranging from brush fire actions to an all-out thermonuclear engagement, and the cost of preparing for all these contingencies is staggering.

"Value engineering tools are available and the opportunity to properly apply value engineering techniques was never better than it is now," he said. "What is needed now is engineers to properly apply them."



First Little Joe 2 Booster Vehicle

Upper section of the first Little Joe 2 launch vehicle is lowered into position on the afterbody at General Dynamics/Convair San Diego plant. White chamber atop the afterbody is a mockup of the Algol solid fuel motor. First vehicle qualification flight is scheduled for summer at White Sands, N.M. (AW Jan. 7, p. 69).

Contracting Changes

New York—Thomas D. Morris, assistant secretary of defense, told the recent Society of American Value Engineers convention here that Defense Dept. cost-plus-fixed-fee contracts will be reduced to about 12½% of the total contract awards by Fiscal 1965 with an eventual annual savings of nearly $700 million.

"It has long been recognized that cost-plus-fixed-fee contracts usually provide no incentive for economy or superior performance," Morris said. "Nevertheless, in recent years, an increasing share of our procurement has been carried out under CPFF contracts, rising from about 13% in 1952 to nearly 38% during the first nine months of 1961."

Morris said that in the first eight months of the current fiscal year cost-plus-fixed-fee contracts have been reduced to about 23.3% of the total.

Morris said the most important method of inducing defense contractors to perform economically and efficiently is to use incentive contracts under which the contractor's fee is increased if he betters the target price and performance goals or is reduced if he fails to meet them.

FINANCIAL BRIEFS

Dynamics Corp. of America reports 1962 sales of $75 million with a net income of $3.6 million equal to $1.05 per share. Sales during 1961 totaled $49.2 million with a $2 million net income equal to 58 cents per share.

Texas Instruments net sales billed for first quarter of 1963, ended Mar. 31, totaled $59,797,000 with profits after taxes being $2,455,000 and earnings reported at 61 cents per share of common after payment of preferred dividends. This compares with sales of $57,483,000, and profits of $2,411,000 and earnings per share of common stock of 60 cents in the same quarter last year. Total backlog at the end of the quarter was approximately $118 million, of which $57 million was directly from government contracts.

Rohr Corp.'s six month sales for the period ended Jan. 31 totaled $52.6 million with earnings of nearly $1.5 million or 75 cents per share. Comparable period ended last year showed sales of $79.6 million with earnings of nearly $2.6 million equal to $1.29 per share.

Thompson Ramo Wooldridge, Inc., reports 1962 earnings of $12.5 million—$3.25 per share—on sales of $460.3 million. Comparable 1961 figures were $6.5 million earned—$1.71 per share—on sales of $409.1 million.

Ryan Aeronautical Co. had net earnings of $787,420 on sales of $19 million for the first quarter Fiscal 1963 ended Jan. 31. Figures for the comparable 1962 period showed earnings of $739,670 on sales of $18.8 million.

Chicago Aerial Industries, Inc., manu-

Marines to Evaluate Ryan Flex-Bee Drone

Ryan Flex-Bee reconnaissance drone and spares, two ground launch systems and radio command equipment, will be evaluated by Marine Corps during a six-month flight test program. Aircraft is powered by a 9½ hp. McCullough MC-30 engine and cruises at about 115 mph. Operating range is several miles and altitude capability is estimated at 5,000 ft. Radio control range is about 2 mi., but control in field use can be extended by using a tracking system and automatic programmer.

facturers of aerial reconnaissance camera systems, had a net loss of $131,994 on sales of $10 million for 1962. Comparable 1961 figures showed a net loss of $310,697 on sales of $9.7 million. Company says 1962 loss was due to first quarter deficit from heavy product engineering costs and contract loss write-offs. Order backlog on Dec. 31 was $8.2 million.

General Precision Equipment Corp., Tarrytown, N.Y., preliminary report shows 1962 sales of $222.9 million with a net income of $4.4 million equal to $2.40 per share. Sales in 1961 totaled $234.6 million with a net income of $5.3 million equal to $3.10 per share. Fourth quarter 1962 sales were $59.8 million with earnings of $1.4 million—77 cents per share. Same period 1961 sales were $63.4 million with earnings of $1.7 million, which was equal to 98 cents per share.

NASA Biotechnology Unit Meets at Ames

Washington—First meeting of National Aeronautics and Space Administration's newly-formed advisory committee on biotechnology and human research will be held this month at the Ames Research Center, Moffett Field, Calif.

Members of the committee are: chairman, Dr. Charles I. Barron, president of the Aerospace Medical Assn., and medical director of Lockheed Calif. Co.; Dr. Robert C. Armstrong, manager of General Dynamics/Astronautics' life sciences section; Dr. Hans G. Clamann, chief of space medicine, USAF School of Aerospace Medicine, Brooks AFB, Tex.; Ben Ettelson, president of Spacelabs, Inc.; Dr. William M. Helvey, assistant manager of Republic Aviation Corp.'s research division; Gerald M. McDonnel, associate professor of radiology, UCLA; Dr. Ross A. McFarland, director of the Guggenheim Center for Aerospace Health and Safety Center, Harvard University; Dr. John L. Mason, chief engineer, AiResearch Manufacturing Co.; Dr. Floro Deo Mruald, assistant professor of nuclear engineering, Case Institute of Technology; and Dr. Rollin M. Patton, of Ames Research Center's bio technology division.

The new committee is one of eleven which advise the NASA Office of Advanced Research and Technology. The new group is to meet four times a year to study and make recommendations on NASA's activities in the field of human research, advanced life support systems, man-machine integration and related experimental research and investigation.

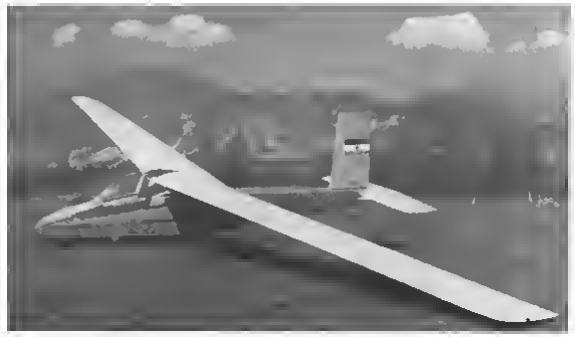
Three Airlines Report Officers' Remuneration

Continental Air Lines, Inc—**L H Moeller**, Chairman of the Board $400 salary 29 287 shares of common stock **R F Six**, President and Director $47 020 salary 5 250 shares of common stock **H L Lawrence** Executive Vice President and Director $58 166 72 salary 4 003 shares of common stock part held in joint tenancy **R M Adams** Vice President-Engineering and Maintenance $26 886 80 salary **H W Bell, Jr** Vice President-Personnel $25 200 08 salary 420 shares of common stock; **A Doman**, Vice President-Finance $41 - 500 16 salary **M L Davis**, Vice President-Sales $26 850 16 salary, 250 shares of common stock; **O R Hooster** Vice President-Operations $27 300 72 salary, 2 168 shares of common stock part held in joint tenancy **B King** Vice President-Public Relations $20 550 salary 1 503 shares of common stock in the name of others; **M Bramer**, Vice President-C/S Plng $23 - 550 16 salary 1 847 shares of common stock; **E B Rees** Vice President-C/S Fld Serv $25 283 salary 106 shares of common stock; **S B. Redmond**, Vice President-Regional Proceed $24 550 16 salary 743 shares of common stock; **R J Schorling**, Vice President-Purchasing $21 800 08 salary 273 shares of common stock; **C F. Whelan**, Vice President Econ Plng $23 - 850 16 salary 285 shares of common stock; **D E Wilson** Vice President-Flight $23 - 850 16 salary 190 shares of common stock; **C A Bocks** Assistant Vice President-Sales $20 000 16 salary 180 shares of common stock; **H R Cady** Assistant Vice President and Treasurer $19 450 16 salary 188 shares of common stock; **P G Coiner**, Assistant Vice President-Fuel Controls, $17 800 08 salary 83 shares of common stock; **G J M. Kelly** Assistant Vice President and Secretary $17 800 08 salary 1 044 shares of common stock; **J R Kersey** Assistant Vice President-In-Flt Serv $19 400 40 salary; **J F Martino** Assistant Vice President-Maintenance $15 850 salary, 48 shares of common stock; **M W R Meyer** Assistant Vice President-Advertising $18 190 08 salary; **F F Keithe, Jr**, Assistant Secretary and Director-Security, $16 166 72 salary 5 shares of common stock; **L C Ames**, Director, $800 salary, 25 050 shares of common stock; **A O Beckmon** Director $300 salary, 450 shares of common stock; **S G Coopie** Director $400 salary 3 425 shares of common stock part held in joint tenancy; **P L. Ehrman** Director, $100 salary 15 000 shares of common stock in the name of others; **M F Reilmon** Director $500 salary 16 525 shares of common stock in the name of others; **L D Reory**, Director $325 salary, 200 shares of common stock; **J G Rolload** Director $500 salary 4 024 shares of common stock; **D A Mimkell** Director, $300 salary 800 shares of common stock; **J A Pritzker** Director $200 salary 16 388 shares of common stock; **F H Rickelsoo**, Director $700 salary, 11 690 shares of common stock; **R J Smith**, Director $400 salary 6 992 shares of common stock; **R Stewart**, Director $300 salary, 185 shares of common stock; **J A Uhl** Director $800 salary 5 373 shares of common stock.

Expense figures for Continental Air Lines' officers will be filed later.

Delta Air Lines, Inc—**C E. Woolman**, President and General Manager, Director $87 538 salary, $1 471 expenses, 56 428 shares of common stock; **Todd A Cole**, Executive Vice President-Administration and Assistant Secretary, Director $52,538 salary $1 041 expenses 1 800 shares of common stock; **Cherice E Dolsno**, Executive Vice President Operations Director, $52 538 salary $537 expenses, 3 217 shares of common stock; **E S Teozler**, Vice President-Legal Director, $38 538 salary, $2 243 expenses, 148 shares of common stock; **W. T. Beebe**, Vice President-Personnel $38 538 salary 150 shares of common stock; **T M. Miller**, Vice President-Traffic and Sales $41 454 salary $2 049 expenses, 124 shares of common stock; **Robert L Griffith** Vice President $38,283 salary $1,228 expenses 148 shares of common stock; **Robert Oppenlander**, Comptroller-Treasurer, $38 283 salary $200 expenses; **E E Whertton**, Assistant Vice President-Personnel $28 371 salary $33 shares of common stock; **Catherine Fitzfgerald**, Assistant Treasurer $8 738 salary, 5 033 shares of common stock; **H H. Soxoo** Assistant Treasurer $16,938 salary $227 expenses; **J E Howell**, Assistant Treasurer, $18 535 salary $71 expenses; **C. R. Wilder**, Assistant Vice President-Oper. Technical $25 121 salary, $155 expenses, 266 shares of common stock; **Paul W. Pate**, Assistant Vice President-Properties, $28 371 $3 332 expenses 125 shares of common stock; **Charles P. Wrecht**, Assistant Vice President-Sales $18 284 salary, $1,362 expenses 864 shares of common stock; **E. W. Freeman**, Chairman of the Board, Director $1,438 salary $12,888 expenses 11 991 shares of common stock; **R W Coorte**, Director 1 338 shares of common stock; **Edward M. Gorey**, Director, $67 expenses 1,402 shares of common stock; **John E Laegmire**, Director $57 expenses, 3 324 shares of common 2 812 shares of common stock in the name of others; **Winship Nonnally**, Director, 17 338 shares of common stock; **Corintoo Potuem**, Director, 9 000 shares of common stock in the name of others; **Emery Flinn** Director 134 shares of common stock; **George M Snellings Jr.**, $58 expenses, 434 shares of common stock.

National Airlines, Inc—**G T Baker** Director, Chairman of the Board (term ended 6/6/62), $39 386 66 salary $9 950 01 expenses, 4 000 shares of common stock; **J C. Brawues** Executive President $27 500 salary $979 74 expenses 1 523 shares of common stock; **J D ttrork** Vice President $24 583 56 salary, $326 06 expenses, 158 shares of common stock; **W B Caldwell Jr**, Assistant Treasurer $21 800 salary $2 763 38 expenses 338 shares of common stock; **E F Dolensky** Vice President $24 279 41 salary $352 15 expenses; **L W Dymood** Vice President $18 188 salary $632 50 expenses, 385 shares of common stock; **W. F. Johnston** Treasurer, $22 - 738 38 salary $518 20 expenses 2,331 shares of common stock; **L B. Moylog, Jr.**, President and Director (term began 4/23/62), $42 133 16 salary $316 26 expenses $3 138 shares of common stock, $221 000 debentures; **John L. Meeris**, Vice President $24 - 300 salary $523 51 expenses 3 383 shares of common stock 7 shares of common stock in the name of others; **W V Nilson**, General Counsel and Secretary $18 302 17 salary, $437 85 expenses; **W. F Prigge** Vice President $28 139 09 salary $1 704 57 expenses $00 shares of common stock; **J M Rosenthal** Vice President $29 500 32 salary $201 35 expenses 5 922 shares of common stock; **H B Taylor** Assistant Treasurer $15 000 salary $873 90 expenses; **M C Wedge** Vice President $38 388 53 salary $347 58 expenses 512 shares of common stock 5 shares of common stock in the name of others; **M V Wells** Assistant Secretary $6 030 84 salary; **R E. Wirlaod** President (term ended 5/31/62) $28 758 salary $2 053 21 expenses; **J Al Wolgasi**, Vice President $26 958 91 salary, $145 83 expenses; **J E Woodly** Executive Vice President, Director $31 030 21 salary $280 72 expenses; **J W Caither** Vice President $21 250 00 salary $375 40 expenses; **R S Grant** Vice President $21 250 08 salary $164 64 expenses, 104 shares of common stock; **A L Stanley** Assistant Vice President $9 750 salary $487 07 expenses 100 shares of common stock; **John W Cross**, Director 661 shares of common stock 185 shares of common stock in the name of others; **John A Love**, Director $200 expenses; **Alfred L McCarthy** Director, 1 585 shares of common stock; **Edwin C McDonald** Director $150 expenses, 12 shares of common stock; **A G McNeese Jr.**, Director $700 expenses 1,149 shares of common stock 13 shares of common stock in the name of others; **Allee Ochsner**, Director $121 84 expenses, 300 shares of common stock; **David Packard**, Director $200 expenses 2 008 shares of common stock; **Paul R Scott** Director 180 shares of common stock; **Dudley Swim**, Director Chairman of the Board (term began 8/2/62), $2 288 18 expenses, 180 000 shares of common stock; **Duolel E Topping**, Director 87 shares of common stock; **C Roberi Trnex Jr.**, Director, $1,882,85 expenses, 1,008 shares of common stock; **Jerome A. Wolermoo** Director $400 expenses, 802 shares of comeios stock; **Geo A C Wedemeyre**, Director $288 expenses, 8 **P B Morse**, Director 1 880 shares of common stock



Yugoslavs Design Two-Place Trainer Sailplane

Two-place Libs-17 sailplane, designed both as a trainer and for competition flying will be used by Yugoslav flying clubs Aircraft has steel tube construction in the fuselage, all movable tail and spoiler brakes Stall speed is 36.7 mph Useful load is 440 kg Wingspan is 55.8 ft, length is 25 1 ft and height is 8.9 ft.

PIPER TWIN COMANCHE is distinguished by broad, flat engine nacelles with glass fiber air intakes. Engines are Lycoming IO-320Bs.

Piper Speeds Twin Comanche Production

By David A Brown

Lock Haven, Pa —First deliveries of Piper Aircraft Corp 's new four-place Twin Comanche will be made this month and production is expected to stabilize at two a day in June

Twin Comanche, designated PA-30 by the company, was developed from Piper's single-engine PA 24 Comanche and received its Federal Aviation Agency type certificate in February

Basic Twin Comanche, minus radio and most instruments, will sell for $33,900 Piper has devised 13 different electronics instrument and interior packages The maximum package combination available will cost $3,990, raising the aircraft price to $37,890 Maximum amount available will cost $11,345 raising the aircraft price to $45,245

Lowest-priced instrument and radio-equipped version, the Custom 90, has standard instruments, some of them reconditioned surplus units, plus a Motorola ADF T 12 B and a Narco Mark 12 90-channel VHF transceiver A separate 100-channel receiver is connected with a VOA-4 VOR/ILS wired for glide slope receiver addition

The highest-priced package—the Professional 422—has two Narco Mark 12 360-channel transceivers plus two 100-channel navigation receivers, a Narco VOA 4 and a Narco VOA-5 VOR/ILS with ILS cross pointer, a Motorola ADF T-12-B, a Narco MBT 75-mc marker beacon receiver with three light-indicators, a Narco UGR 1A glide slope receiver, a Narco DME and a Piper Alti-Matic 2 three-axis autopilot

Piper expects the Twin Comanche to create a niche for itself in the company's marketing setup, capturing owners who have been flying aircraft in the Bonanza-Cessna 210-Comanche 250 category

J W Miller, Piper sales manager, said that while he expects 475-500 Twin Comanches to be sold during the first year or so it is on the market, he does not expect a decline in sales of comparably priced single-engine aircraft

He said that this had been the history of new aircraft on the business flying market in recent years—instead of capturing some of the market which had previously gone to earlier aircraft, they tend to create a new market and leave earlier ones relatively undisturbed

At the two-per-day production rate, it will probably be about eight months before the initial demand for the aircraft is satisfied, but Miller said that a preliminary survey indicated that over a long period of time this would be the rate of production which could be justified by sales

Aircraft is powered by two Lycoming IO-320-B fuel injection engines mounted in slimmed nacelles and with the air induction and fuel injection packages located at the rear of the engine Engines are rated at 160 hp each at 2,700 rpm

Top speed claimed by Piper for the Twin Comanche is 205 mph and optimum cruise speed is 194 mph at 75% power and 8 000 ft Cruise speed at 65% power and 12 000 ft is 186 mph

Gross weight of the Twin Comanche is 3,600 lb and useful load of the standard model is 1,440 lb Maximum cruise range at 65% power and 12,000 ft. is 1,025 mi The Twin Comanche has a fuel capacity of 90 gal of which 84 gal is usable Four fuel cells, two in each wing, are provided with NACA non-icing vents

Fuel selector system is located on the cabin floor between the front seats and provides a cross feed arrangement so that either engine may be operated from any of the four fuel cells

Glass fiber is used extensively in the Twin Comanche Fuselage nose section is made of glass fiber and contains a single air intake hole which feeds air to a plenum chamber from where it is used for cabin heating and cooling, and avionics cooling

Distinctive glass fiber air intake sections of the engine nacelles are made possible by extension of the propeller hub 6 in Extended hubs are integral with the normal propeller hub

Propellers are 72-in lightweight Hartzell models which are constant speed and have full feathering capability

New design vertical fin and rudder has been used to improve rudder effectiveness for engine-out operation Movement of the engines from the nose to the wing has allowed the nose wheel retraction well to be moved forward 9 in , reducing the hump in the cabin floor found in single-engine Comanches and providing more leg room

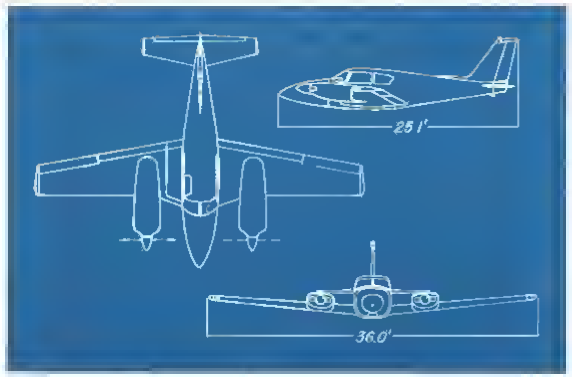
New fin is 6 in taller than the fin on single-engine Comanches and has 1 4 additional square ft of area

Horizontal tail is the same design platform as on the single-engine Comanche, but was beefed up to accommodate the higher speeds and gross weight It is an all movable stabilator design Stabilator tab operating mechanism also was strengthened Glass fiber tail cone ends the fuselage

Major changes in the structure of the Comanche consist chiefly of a beef-up of both the wing and fuselage to take the extra loads imposed by two engines and the re-distributed weight Nose gear mounting has been designed to fit the mounting points of the engine mount in single engine aircraft

Fuselage was reinforced with thicker gage aluminum skin from the nose back to approximately the trailing edge of the wing, bulkheads were strengthened and reinforced and hat section stringers were placed vertically to strengthen the skin Some longitudinal stringers were lengthened to overlap bulkheads they formerly fit flush against Rivets were increased in size and number

Increase in height of the vertical tail and increased area of the tail added to



WINGSPAN of the Twin Comanche is the same as the single-engine aircraft from which it was developed. Three-view shows nacelle, vertical fin layouts.

ENGINES ARE MOUNTED in the forward section of the nacelles, ahead of the air induction and fuel injection packages. Quick release fasteners allow cowling to be removed rapidly

INTERIOR of the four-seat Twin Comanche is similar to that of the single-engine Comanche Sports car type bucket seats are leather covered Below access plates cover circuit breaker panel, forward, and emergency gear release system, center Fuel management controls are rearmost

the loads transmitted to the rear of the fuselage and required a strengthening of the bulkheads in that area.

Landing loads from the nose gear, partially absorbed by the engine in the single-engine Comanche, now are transmitted to the fuselage. This new loading was counteracted by the structural strengthening of the fuselage as was the increased loading transmitted by the forward wing spar, due to the additional weight of the engines on the wing. Engine loading tends to twist the wings chordwise.

Wing area remains the same as for the single engine Comanche, but the structure has been strengthened to carry the new loads imposed by the engines and increased gross weight and top speed. Forward wing spar has been extended to approximately two-thirds the span of the wing and the attachment point for this spar has been strengthened at the fuselage.

Heavier leading edge skins have been used, a heavier root rib was attached and the rear spar attachment point was given extra rivets. Entire inboard wing was strengthened, particularly the area

Twin Comanche Specifications

Length	25.1 ft
Height	7.3 ft
Span	36 ft
Engines	2 Lycoming IO-320-B 160 hp at 2,700 rpm
Gross weight	3,600 lb
Empty weight	2,160 lb
Useful load (standard model)	1,440 lb.
Propeller dia	72 in.
Fuel capacity	90 gal 84 gal usable
Wheel base	7.3 ft
Tread	9.8 ft
Baggage space	20 cu. ft
Power loading	11.25 lb./hp
Wing loading	20.22 psf
Top speed	205 mph
Cruising speeds	
75% power at sea level	191 mph
75% power at 8,000 ft	194 mph
65% power at 12,000 ft	186 mph
Stall speed power off, flaps down	69 mph
Take off distance over 50-ft. obstacle	1,570 ft
Landing distance over 50 ft. obstacle	1,875 ft.
Twin engine rate of climb	1,460 fpm.
Single engine rate of climb	260 fpm
Service ceiling	18,600 ft
Single engine service ceiling	5,800 ft
Fuel consumption, 75% power	17.2 gph
Fuel consumption, 65% power	15.2 gph.
Cruise range, 75% power	948 mi
Cruise range, 65% power	1,025 mi

around the landing gear [illegible] points.

Engine nacelle aft of the firewall is made as a unit, then riveted to flange attachments which in turn rivet to the wing. Landing gear for the outboard fuel cells had to be moved outboard to prevent it from being covered up by the engine nacelle.

Landing gear forgings were increased in size and a larger strut is used. All three wheels used are 6.00 x 6 with 6 ply rated tires. Metallic brake linings rather than organic ones are used since metal brakes do not fade when hot. Piper says it expects them to last approximately twice as long as organic brake linings.

Cowl Flaps

Cowl flaps are used on the Twin Comanche, the first Piper airplane in a number of years to have them. However, the company says they are needed only when the aircraft is being flown with one engine out, making repeated touch-and-go landings or operating where the ambient air temperature exceeds 100F.

Nacelle panels are attached with quick opening panels which can be stripped away in about 5 min. Push button operated oil filler door provides access to the filler neck, which has a lever-actuated, O-ring locked dipstick and filler cap.

Air induction system at the rear of the engine contains a paper air filter and an air box with a spring-loaded alternate air door. Door also may be controlled manually from the cabin.

Electrical system is 12 v. with a 12 v., 35 amp hr. battery and a 12 v., 50 amp generator on the left engine. Provision has been made for a similar generator on the right engine as optional equipment.

Fuel System

Fuel system has two electric and two engine driven fuel pumps. Selector valves located on the cabin floor between the front seats prevent both tanks from being placed in the crossfeed position at the same time. This would result in fuel starvation for both engines.

Fuel crossfeed is by suction rather than fuel pump action and requires no boost to transfer fuel.

Fuel drain system also works through the selector system, allowing fuel from each tank to drain through a clear plastic tube which the pilot can see. In line electric fuel boost pumps are located beneath the selector panel and contain integral check valves and pressure regulators. They supply fuel to the engine driven double diaphragm pumps.

Fuel for the nose-mounted cabin heater is taken from the fuel line between the right engine-driven pump and the engine fuel injector. Fuel from the engine injectors goes to flow dividers from which the dual fuel flow indicator instrument receives its information.

What formerly was a steel firewall in the single-engine Comanche now is an aluminum plate which contains a mounting bracket for electrical equipment which had to be housed inside the cabin in single engine models.

Controls and instrument lines are routed from the cabin forward through the firewall, then back along the sides of the fuselage and into the wings. This eliminates sharp bends in the cables and reduces the possibility of sticks or hard to operate controls.

Interior Design

Cabin interior design reflects the change from single- to twin-engine configuration, but basically it is the same as in previous Comanche models. Engine control pedestal has been added and features snap off side panels to facilitate maintenance.

Circuit breaker panel is recessed into the floor and covered with an access plate. Immediately rearward of the circuit breakers is the emergency gear operation control, also recessed and covered. Emergency extension system uses a two-socket arrangement to prevent injury to the operator should the gear fall free after the actuating motor is disengaged.

Cabin roof has redesigned trim cranks and indicator dome light and individual map lights for the two front seats. Sound proofing consists of an anti-noise blanket which has been added to the sound-proofing of the single-engine Comanche. Blanket extends under the side panels, headlining and floors. Redesigned floorboard now is attached with screws rather than rivets.

Side windows now are double-pane, rather than single pane, and contain ¼ in. airspace between .080 in. thick outer panes and .030 in. thick inner panes.

Eleven paint variations and interior coverings are available.

U. S. Business & Utility Plane Shipments

February 1963

Make & Model	Units	Net Billings
Aero Commander 500A, B, 680FP	5 2	$596,000
Beech Super 18 23 Musketeer 33 Debonair 35 Bonanza 50 Twin Bonanza 55 Baron 65 Queen Air 80 Queen Air 95 Travel Air	2 60 8 14 3 10 8 8 2	$3,620,000
Cessna 150 172 Skyhawk P172 180 182 Skylane 185 Skywagon 205 210 310 320 Skyknight	30 83 8 8 45 7 48 18 10 3	$3,315,000
Champion 7FC5 Challenger	6	$68,000
Mooney M-20D Master M-20	22 11	$431,000
Piper PA 18-95 Super Cub PA 22-160 Colt PA 23-235 Apache PA 23-250 Aztec PA 24-180 Comanche PA 24-250 Comanche PA 25-150 Pawnee PA 25-235 Pawnee PA 28-[illegible] PA 28-160 Cherokee PA 28-180 Cherokee	15 11 33 38 7 22 1 23 1 9 40	$2,848,000
Totals	838	$11,560,000

Note: Total Jan.-Feb. 1963 shipments from the factories number 1,126 aircraft having a net billing value of approximately $21,218,000. In the same period last year, 1,133 units were shipped having a total net billing value of some $23,182,000.

PRIVATE LINES

Fairchild Aerial Surveys, division of Fairchild Camera and Instrument Corp., has purchased four new Cessna aircraft for use in its aerial mapping operations. The new aircraft—two Model 320s, a Model 310 and a Model 205—will be modified at the Cessna factory for geophysical exploration and mapping work. Purchase brings to 13

the number of aircraft operated by the mapping company.

Centedime JATO auxiliary power installation for Piper Apache and Aztec light twins has been approved by the Federal Aviation Agency. Installation, developed by Mateo, Linden, N. J., has a total weight of 52 lb., including propellant, bottle, brackets, wiring and controls. Mateo is offering the unit in kit form or installed.

Aero Commander, Inc., has sold 30 Jet Commanders to date, an increase of 12 since the aircraft's first flight Jan. 27. This equals 15% of the total 200 aircraft market forecast for the end of 1963 by the Federal Aviation Agency. First deliveries are scheduled for about the first of the year.

New blimp, designated the Columbia 2, will be built by Goodyear Tire and Rubber Co. and its present blimp Mayflower will be reconditioned this summer. Program will cost $1.4 million. Both blimps will tour the country in the fall.

Rule restricting use of portable FM radios in all civil aircraft has been extended indefinitely by the Federal Aviation Agency. Rule prohibits use of FM receivers in private civil aircraft when VHF radio navigation equipment is in operation. Operation of FM receivers in commercial aircraft is banned at all times.

North American Sabreliner has received its Federal Aviation Agency type certificate. First delivery will be made this month. NAA's civil designation for the 6-8 place, twin-jet executive aircraft is NA-265-40. Distributor for the aircraft is Remmert-Werner, Inc., of St. Louis.

Four Hiller E4 helicopters have been delivered to two companies for use in off-shore oil operations. British United Airways will operate two off the coast of Nigeria. PEMEX, Mexican government-owned oil company, will operate two off the coast of Mexico. National Aeronautics and Space Administration has purchased a Hiller 12E for experimental work with vertical lift aircraft at Moffett Field, Calif.

Federal Aviation Agency is proposing a new Technical Standard Order (TSO) establishing minimum performance standards for synthetic aircraft covering fabric. Interested parties may participate in discussion of the proposed rule by writing the Docket Section, Federal Aviation Agency, Washington 25, D. C. before May 31.

MAJORITY OF WILKEN'S BUSINESS is conducted from this headquarters at the old Wilson Airport, about seven miles from the heart of Nairobi and bordering on the Royal Nairobi Game Park. Smaller base is maintained at Mombasa on the Indian Ocean coastline.

African Operation Handling Varied Tasks

By Robert H. Cook

Nairobi, Kenya—Wilken Air Services, established three years ago to fill Kenya's growing need for better internal communications, is an outstanding example of the vital role played by a fixed-base operator in the development of air minded East Africa.

Wilken is a small company—30 employes—but has had a phenomenal rate of growth since it first began operations with three aircraft. Its original business, which consisted primarily of flying instructions and maintenance contracts, has expanded to a point where the company now has a fleet of 18 aircraft and a second base at Mombasa.

The firm is the Piper Aircraft distributor for East Africa and Lycoming engine dealer for the same territory plus the Sudan and Ethiopia. Wilken performs maintenance and overhaul work for at least 20 other aircraft owned by such organizations as the African Medical Research Foundation, African Wildlife Society and the South Air Police. Pipers dominate the Wilken fleet, which includes three Comanches, four Caribbeans, two Colts, one Cruiser, one Tri-Pacer and one Cub.

Two Cessna 182s, along with a 180, a 170 and 210, and an Aermacchi Lockheed 60 make up the balance of the fleet.

Average monthly flight time on the aircraft is 50 hr., although some occasionally reach 100 hr. Cruisers, Cubs and Colts are generally used for flight instruction, which now totals about 150 hr. a month. More than half of Wilken's force of 15 pilots has instructor ratings. Courses in commercial and instrument ratings are given with Link Trainer time acquired through the Division of Civil Aviation of the Common Services Organization. Majority of the maintenance and overhaul work is done by seven European mechanics.

Rapid fleet expansion has permitted the company to branch out into more lucrative areas, such as servicing film location units and safaris. Good location sites are now spotted from the air, and Wilken has transported casts and the daily film production of such notable movies as "Hatari," which was filmed near the Amboseli Game Preserve, and "The Lion," made around actor Wil-

OPERATIONS ROOM of Wilken Air Services is dominated by map showing location of every available landing strip and airport in Kenya, Uganda, Tanganyika and Zanzibar. Location pins are also used to plot the progress of various safaris, film projects and government game surveys being serviced by the company.

AERMACCHI LOCKHEED 60 is used by Wilken for jobs requiring either all cargo aircraft or combination cargo-passenger configuration. Designed for rough bush operations, the aircraft has a reinforced airframe and flooring, plus wide track landing gear to reduce landing impact. Wide-hinged, upswing door, permits easy loading of bulk cargo, such as the shipment of monkeys shown being loaded above.

ham Holden's famed Safari Club at Nanyuki.

Such operations as Wilken's have also changed safaris. Hunters no longer must endure a bone-wracking journey of several days in a Land Rover safari wagon. They now wait until the outfitter establishes camp and radios back the precise location. Clients then fly the 400 to 600 mi. in a matter of a few hours.

As Africa's population growth rate continues to increase, forcing wildlife into small protected areas, game surveys have become steady business for the company.

Aerial Surveys

As an example, wildlife authorities estimate that the great Tsavo National Park is now supporting an elephant population of 15,000 head, rather than the 6,000 previously estimated. The difference was not apparent until low-flying aircraft began flying a criss-cross grid pattern across the park nearly two years ago. Today, this type of aerial survey is made every three months by teams of wildlife experts using Wilken Air Service aircraft. An accurate count can be made in two days as opposed to a week using the old ground count method.

In its continuing search for new markets, Wilken has opened a fishing camp on the shores of Lake Rudolph in the wild Northwest Frontier district and a beach resort near Malindi on the Indian Ocean.

Like most African countries, the combination of weather and topography often makes air transportation the only practical and economical means of travel in East Africa. From October through December, the country experiences a period of intermittent rainfall, and from March to May, heavy tropical downpours which make it impossible to use most unsurfaced roadways.

Wilken's rates per mile for charter aircraft are well below that charged for the hire of a car and driver. On a round trip basis, air travel has an advantage of 40 mi. over autos to such points as Nyeri, location of the famed "Treetops" house in the Abadare National Forest and last stronghold of the Mau Mau movement.

To such far off points as Kampala and Lammu, the difference is 200 and 400 mi., respectively.

While the company has pursued new markets aggressively, much of its success can be traced to a policy of precise bookkeeping and sharing of profits with the employes, according to Managing Director John Williams.

Aircraft Devaluation

During the first year of operation, all aircraft were devalued by 35%, and this formula has continued so that the book value of each aircraft, at any time, is equal to current sale price available on the open market.

Each of Wilken's original pilots and mechanics are shareholders in the company and all employes, including Africans, are awarded a cash bonus and non voting stock at the end of each year. Distribution of the bonus and stock is accomplished through a point system based upon years of service, salary, licenses held and extra points awarded by either department heads or directors.

NEW AEROSPACE PRODUCTS

Sweep-Random Oscillator

Oscillator generates a random signal swept across particular frequency bands which can be applied to the amplifier of a shaker for simulating random vibrations found in missiles, space vehicles and aircraft.

Oscillator is designed to supplement rather than replace wide-band random testing. Advantage of the sweep-random oscillator, the manufacturer says, is that conditions of wide-band testing can be closely simulated at a fraction of the cost of wide-band equipment.

MB Electronics, 781 Whalley Ave., New Haven 8, Conn.

Tracking Mount

Two-axis tracking mount for optical trackers, cameras, etc., is equipped with zero backlash direct drives with 2 sec. of arc accuracy and real-time digital target position data, the manufacturer says.

Called the Model 312 Two Axis Tracking Mount, the unit can support instruments weighing as much as 150 lb. Model 312 is available with continuous rotational freedom or cushioned limit stops. Starting friction is less than 15 in./oz. with a 40 lb. load. Axis orthogonality is within 15 arc seconds, the manufacturer says.

Power-Tronic Systems, Inc., Pine Court, New Rochelle, N. Y.

Sound Level Meter

Solid state, self-contained meter Type ELZT, provides accurate indication of airborne sound levels between 30 and 120 db at frequencies ranging from 30 to 12,500 cps, the manufacturer says.

Slide switch selects overlapping sen-

sitivity ranges of 30-50, 40-60, 50-70, 60-80, 70-90, 80-100, 90-110, and 100-120 db.

Instrument accuracy equals or exceeds International Electrotechnical Committee (IEC) standards. Fast or slow meter time constants, in conformance with IEC standards, are selected by push button.

Meter is quickly calibrated with an internally supplied standard. Audio outputs are provided for external monitors, spectrum analyzers or recorders. Microphone is electrostatic, instrument is battery powered, and a 110 v. battery charger is included.

Rohde & Schwarz Co., Inc., 111 Lexington Ave., Passaic, N. J.

Plunger-Actuated Switch

Plunger-actuated switch for use in missiles for stage separation and other functions can sustain random vibrations as high as 200 rms applied 30 sec per axis, 5 to 2,000 cps, and shocks to 100g, the manufacturer says.

Design provides configurations ranging from single-pole, single-throw to

five-pole, double-throw at current ratings to 25 amp. Unit weighs 8 oz and is filled with inert gas to provide constant dielectric strength at any operating altitude.

Specifications: 100 mv max. voltage drop at full rated load; dielectric strength 1,250 v.a.c. at sea level, circuit to circuit or circuit to case; insulation resistance, 100 megohms/min. at 500 v.d.c. between any insulated elements; —65F to 165F operating and storage temperature.

Kinetics Corp., 410 So. Cedros Ave., Solana Beach, Calif.

WHO'S WHERE

(Continued from page 19)

Changes

Alexander N. Beichek, assistant director of research and engineering, Aero-Space Division of Walter Kidde & Company, Inc., Belleville, N. J.

Richard W. Ehrhorn, supervisor of advanced development, Electronic Communications, Inc., St. Petersburg, Fla.

John J. Foley, materials manager, Relay Div., Leach Corp., Los Angeles, Calif.

Frederick R. Freymuller, market development manager, Sperry Utah Co., Salt Lake City, Utah, a division of Sperry Rand Corp.

Milton Magid, chief engineer-microwave products, Singer Metrics Div., The Singer Manufacturing Co., Bridgeport, Conn., and **Vincent P. Cronin**, technical adviser-electrical instruments.

F. M. Thuney, director of manufacturing, Robertshaw's Aeronautical and Instrument Div., Anaheim, Calif.

Elder Wester, manager of operations at Edwards AFB for United Technology Center, Sunnyvale, Calif.

Albert S. Humphrey, manager of the Management Survey Team at General Dynamics/Astronautics, San Diego, Calif.

Robert H. Cline, assistant to the general manager of Northrop Corp., Palos Verdes Estates, Calif.

Joseph L. Wosser, Jr., assistant manager, Aerospace/Rockets Division of Textron's Bell Aerosystems Co., Buffalo, N. Y.

Samuel H. Auld, general manager of the newly formed Electronics Division of Lear Jet Corp., Wichita, Kan.

Frank J. Todd, marketing manager, Radio Corporation of America's Aviation Equipment Dept., Los Angeles, Calif.

Robert P. Boyle, deputy director of the Federal Aviation Agency's International Aviation Service, replacing Capt. **Donald E. MacIntosh** (USN), retiring July 1. **W. Lloyd Lane** has been named deputy director of the FAA's Flight Standards Service, succeeding **George S. Moore** (AW Apr. 29, p. 101). **Lt. Col. Patrick F. Clark** (USAF) has been named military assistant for Materiel Management, FAA's Installation and Materiel Service, Materiel Management Div.

Edward Kuebert, value engineering manager, Engineering Dept., Fairchild Space and Defense Systems, Syosset, N. Y., a division of Fairchild Camera and Instrument Corp.

George E. Jacques, operations manager, Thompson Ramo Wooldridge Microwave Div., Canoga Park, Calif.

Caleb B. Hurtt, Titan I program director, Martin Denver (Colo.) Div., Martin Marietta Corp., succeeding **David S. LeVine** (AW Apr. 8, p. 114), and **George Damstedt**, Titan I project engineer.

Dr. Milo P. Hnilicka, chief scientist, Contract Research Div., National Research Corp., Cambridge, Mass.

Loren Kolste, manager of operations, Good-All Capacitors/TRW Electronics, Ogallala, Neb., a subsidiary of Thompson Ramo Wooldridge Inc. Other appointments in the division's military unit: **K. A. Hagge**, sales manager, military and industrial products, **Troy Pestel**, engineering manager.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management technical, selling other skilled manual etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

NATIONAL COVERAGE

Positions Vacant
Positions Wanted
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Subject to Agency Commission.

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Major multi-division corporation has requirement for executive to direct estimating and pricing activities. Will report to corporate Vice President and will be responsible for basic pricing policy and for all aspects of risk-profit analysis. Broad background in estimating for major systems and large scale projects essential. Specific experience in aerospace or electronic industry required.

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Opportunity for power plant engineer with a minimum of 15 years experience in aircraft power plant design to fill supervisory openings in Engineering Design Department of a leading West Coast helicopter manufacturer. Applicant must have experience in all phases of turbine engine installation design and in overseeing other designers. Helicopter application design experience desired.

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An equal opportunity employer

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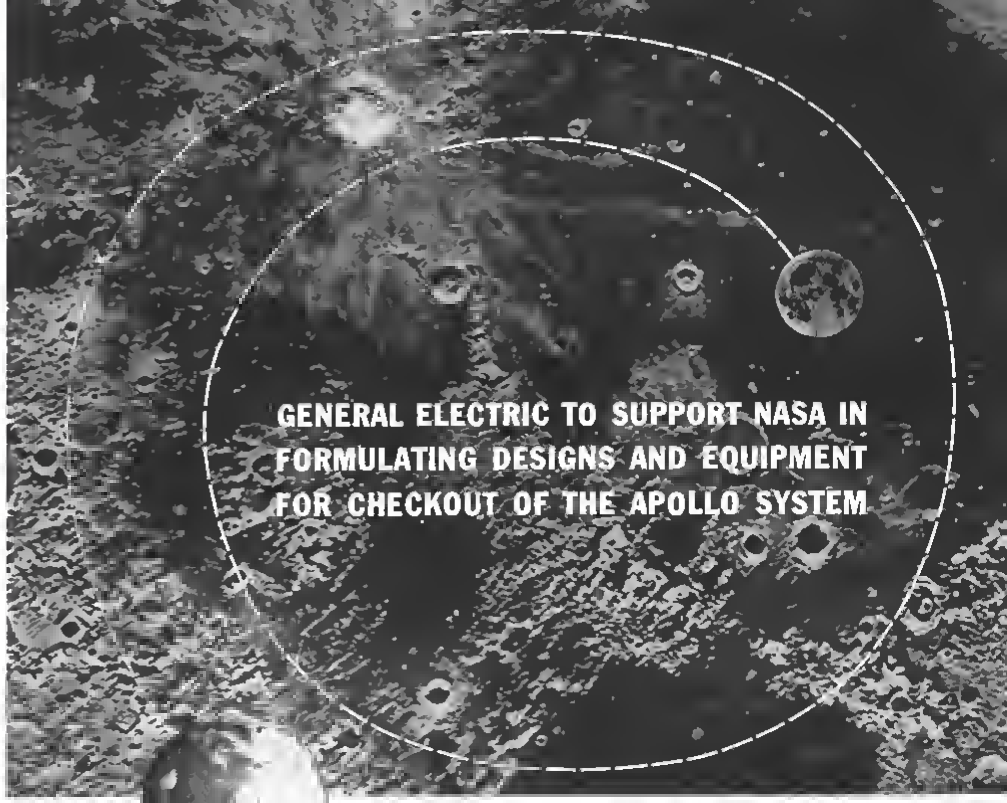

The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

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If you have experience in any of the listed areas write us today (include salary requirements). Your inquiry will be held in strict confidence. Write to Mr. P. W. Christos, Professional Placement, Section G4-C Apollo Support Department, General Electric Co., Support Building, Daytona Beach, Florida.

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This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: structural design, electrical/electronics, propulsion, aeronautics, systems test, mechanical design, industrial, manufacturing, facilities, high vacuum, astrodynamics, cryogenics and thermodynamics.

Salaries are commensurate with all levels of education and experience. Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly-hired engineers.

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn, and other missile and space programs at Boeing—including the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle—are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

Send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088 AWW, New Orleans 26, La. An equal opportunity employer.

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P-2187 Aviation Week/ST
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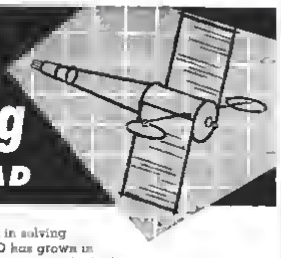

★ Since its first successful work in solving re-entry problems Avco/RAD has grown in proportion to the nation's aerospace and missile requirements. Avco's leadership offers Engineers a genuine opportunity to participate in a number of here-and-now projects which demand creativity and stimulate your professional growth

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  - Radar Fuzing Systems
  - Electrical Ground Support Equipment
  - Nuclear Hardened Electronics
  - Space Power Sources
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  - Electromagnetic Scattering Theory
  - Plasma Analysis
  - Advanced Multiplexing Techniques
  - Information Theory
  - Nuclear Radiation Effects

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- *Structural Loads*
- *Structural Analysis*
- *Dynamic Analysis*
- *Structural Testing*
- *Solid Mechanics*

SPACE FLIGHT-TEST TECHNOLOGY

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- *Aerodynamics*
- *Systems Evaluation*
- *Trajectory Analysis*
- *Test Range Technology*

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- *Operations Research*
- *Game Theory*
- *Management Systems*

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★ The Division's facilities are located in Wilmington, Lowell and Lawrence, just north of metropolitan Boston. At Avco/RAD you are close to leading universities, cultural events and excellent recreational facilities.

Send resume to Mr. J. Bargin, Dept OTA

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Some really important parts of this picture don't show. They are the technical papers inside the brief cases of these Cornell Aeronautical Laboratory staff members — papers ready for presentation at last January's IAS meeting in New York.

CAL men were selected to present five papers* at this national aerospace conference — an indication of the caliber of the Laboratory's research programs and the staff's active participation in technical societies.

The vigorous climate of applied research at Cornell Aeronautical Laboratory — coupled with ample opportunities for internally sponsored research, a unique educational advancement program, and active participation in professional societies — has produced the wide range of competence in applied mechanics and hypersonic aerodynamic research reported in the IAS papers. The Laboratory also has similar far-reaching programs in computer science, flight research, vehicle dynamics, life sciences and systems research. If your capabilities qualify you to be a part of this picture, send the coupon. You'll receive an interesting briefing on this community of science.

Some positions are available at our Washington Projects Office as well as in Buffalo.

*Boarding the plane left to right: *Orren Tufts, who wrote "Dynamic Derivative Measurements in a Wind Tunnel"; Gino Ludwig and Gordon Brady co-authors of "Theoretical and Experimental Studies of Impinging Uniform Jets"; Dr. Walter Gibson, who wrote "Nonequilibrium Shock Layers with Radiation Transfer and Species Diffusion"; and Charles Gates, who co-authored "Comparison of Theoretical and Experimental Flutter Characteristics for a Model Rotor in Translation Flight" with Raymond Prasil and Frank DuWaldt (both not included in this photo). Also not appearing in the photo was Dr. Hsien Cheng, author of "Recent Developments in the Theory of Viscous Hypersonic Flow around Blunt Bodies."*

CORNELL AERONAUTICAL LABORATORY, INC.
OF CORNELL UNIVERSITY

J. V. Rentschler NY
CORNELL AERONAUTICAL LABORATORY, INC.
Buffalo 21, New York

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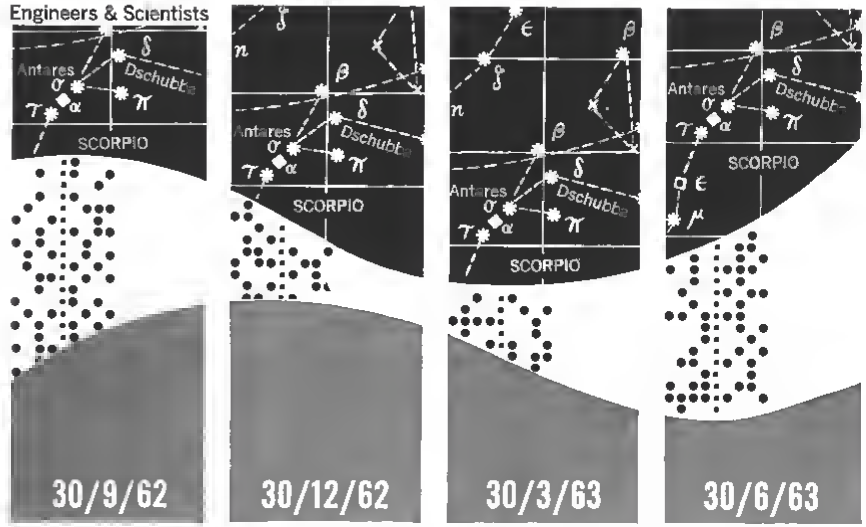

digitizing a star almanac

for missile and spacecraft navigation

Many advanced concepts and techniques — aimed at lifting the state-of-the-art in stellar-inertial systems — are under study at General Precision Aerospace. Among them is the feasibility of a microminiaturized digital computer memory, covering position references of selected stars, hour by hour, throughout the year.

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General Precision Aerospace is one of three firms in the country with full, in-house capability to design, develop and provide systems management for complete celestial-inertial guidance and control systems. It offers qualified engineers and scientists an outstanding opportunity to gain high professional competence in an advanced area of missile and spacecraft technology . . . and to grow with a growing organization.

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YOUR INQUIRIES ARE INVITED REGARDING THESE OPENINGS

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Specialists to analyze vehicle compartment environments and design state-of-the-art air conditioning and power systems. A) experience in vacuum-accustics or B) experience in solar energy, battery, thermo-nuclear, electrostatic spare power sources.

ELECTRO-OPTICAL SYSTEMS ENGINEERS
Evaluate and specify systems such as star sensors, horizon scanners and solar sensors. Prefer E. E. familiar with IR sensors and associated circuit techniques. Optical systems background desired.

SYSTEMS ANALYSIS AND SYNTHESIS – SR. STAFF ANALYSTS
Analytical work in areas of feedback control and inertial guidance systems at concept stage where guidance equations, systems evaluation and dynamic performance of guidance sensing loops are to be studied.

MISSILE FLIGHT CONTROL ENGINEERS – ADAPTIVE/OPTIMAL
Original analysis and systems design of major systems for missile and space vehicles. Will work closely with inertial guidance systems engineers to tie in flight control integrated equipment to associate and subcontractors and insure operational reliability.

INERTIAL GUIDANCE SYSTEMS – PROJECT MANAGERS
Comprehensive knowledge of inertial or hybrid inertial systems to determine optimum systems parameters and configurations specify and integrate stable platform gyro stabilizers and computer sub-systems into state-of-the-art stellar inertial guidance systems for a mobile ballistic missile.

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Analyze systems requirements and prepare specifications to sub-contractors for air/space-borne computers of state-of-the-art nature.

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Analyze systems requirements and prepare spec packages for distribution to associate and sub-contractors.

ADVANCED PROGRAMS – PROGRAM MANAGERS AND SR. STAFF ENGINEERS
A newly formed branch of our Aerospace Systems Division is being staffed at senior levels and requires talented technical and managerial candidates who will be concerned with all phases of the future. Areas now requiring additional key engineers are: Advanced Systems R&D – Aerothermodynamics – Electronics and Communications – Aero-dynamics – Structures and Materials – Astro/Aerospace Physics – Applied Math and Computation – Reliability – Human Factors – Advanced Systems Requirements and Development – Guidance, Computer, Control and Radiation Systems Engineering – Systems Integration – Mechanical Systems.

Write in confidence to Mr. Paul Kuhl, Dept. 17E, General Precision Aerospace, Little Falls, N. J.

GENERAL PRECISION AEROSPACE
GENERAL PRECISION INC.
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SEARCHLIGHT SECTION

(Classified Advertising)

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EV 8-3277

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No Cost or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT" to locate surplus new and used aviation equipment and components not currently advertised. (This service is for USER or USING firms only.)

How to use: Check the dealer ads to see if what you want is not currently advertised. If not send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to

Searchlight Equipment Locating Service
c/o AVIATION WEEK
P O Box 12, N Y 36, N Y

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly for them.

Searchlight Equipment Locating Service
c/o AVIATION WEEK
P O Box 12, N Y 36, N Y

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NEW YORK 36: P. O. Box 12
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Douglas DC-3's, Wright 602A's-Airline configuration and equipment. Standardized 25 or 32 per passenger individual or fleet units available. TSO on airframes 14,500 engines very. Spares available. Full specifications upon request. FS 2122, Aviation Week/S.T.

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— to help you get what you want — to help you sell what you no longer need.

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For Every Business Want

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, MAY 6, 1963

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LETTERS

Astronaut Diet

What with Cinnman's Betty Crocker approach to spacecraft structure (AW Apr 22 p 34) the Apollo astronants should eat well For launch they'll be sandwich panels for dinner, boiled leg of LEM

William J Williamson
North Hollywood, Calif

Re Edible Space Structure Material Tested

Perhaps the only patented edible structure the Grumman attorneys can find is the ice cream cone, but I'll bet I know why Dr Schwartz's patent will be on the process rather than on the concept Several years ago there was a New Yorker cartoon (I can't remember whose) of an invention with a caption about like this "I call it 'sonic' It can be sawed drilled machined and in an emergency eaten with a light sance"

John W Gray
Pleasantville, N Y

Fuel Contaminants

Your article on p 40 of the Apr 22 issue on jet fuel contamination almost missed the point completely Micro-organisms in the fuel are only one part of the problem Almost all fuels contain a great variety of micro organisms but they cause trouble only in conjunction with other contaminants

The five contaminants which interact to cause deposits and corrosion in aircraft fuel tanks are micro-organisms water salts rust and "surfactants" No one of these contaminants by itself will cause trouble but any two or three of them in combination will

Pure water such as condensate or water actually dissolved in the fuel will not cause corrosion problems in properly constructed aircraft but ground water or sea water hal last which may enter the aircraft with the fuel will contain salts which will aggravate the problem Therefore only fuel with no free water should be delivered to an aircraft

Rust by itself causes no real problem but in conjunction with other contaminants it can help promote corrosion

"Surfactants" or surface active agents such as sodium naphthenate or sodium sulfonate in themselves do not cause corrosion but when present in very small concentrations can interfere with the operation of the filter/water separators in fuel handling systems and allow rust and free water to pass through They also can prevent the water and rust from settling out in storage

When water rust and salts do get into an aircraft tank and settle on the structure then micro-organisms can grow at the fuel/water interface Water salts and fuel are all necessary for their growth, and rust seems to promote their growth The micro-organisms, in turn, give the other contaminants in place on the structure so that corrosion can start through the topcoating material

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The products of metabolism of the micro-organisms may solubilize rust so the iron can enter into the corrosion reaction with the aluminum

From the above discussion it is obvious that best approach is to deliver only clean dry fuel to the aircraft rather than to try to sterilize the fuel "Good housekeeping" can prevent this problem as evidenced by the many jets flying without having any corrosion or deposits

Added protection can be given the aircraft tanks in the sump areas by applying a polyurethane coating over the Buna N Coating

The anti-icing additive mentioned in your article may or may not inhibit growth of micro-organisms but it does tend to soften the Buna N Coating and should be used with caution if at all

If the use of a biocide is to be considered as a crutch to good housekeeping compounds which do not soften the top-coating and which have more pronounced biocidal activity should be considered such as Soltio's "Boron" additive

Gordon Walker
Anaheim, Calif

(Aviation Week & Space Technology's story referred to Mr Walker reported both the opinions of many airline sources that good housekeeping is the best solution to fuel contamination problems and also the arguments favoring additives — Ed)

'Little Guy' Critic

The March issue of FAA Aviation News gives an account of the FAA Project Little Guy, which seeks to develop a simplified and more efficient cockpit for the general aviation pilot according to statements in the article

After reviewing the description in Aviation News I think that all general aviation pilots and taxpayers have reasons to be concerned over another costly and unjustified government project

Certainly it is fine to think about progress and improvements and admittedly it is easy to get stuck in old worn tracks as regards instrumentation cockpit layout or overall concept However, I don't believe that our nation which has the most advanced aviation in the world—be it military commercial or general aviation—needs a government agency to tell its aircraft manufacturers where research and development is required to make their products better and to broaden the market Private initiative and enterprise together with sound economic rules which this nation was founded upon, still is a pretty good base

Project Little Guy indeed does not seem to pay much attention to the little guy judging by the complicated and therefore necessarily expensive proposals it contains To mention a few (1) pictorial navigation display on map with inputs from electronic navigation equipment, (2) dial showing hours of fuel remaining at current speed (3) direct readout of ground speed, and (4) transponder equipment

The above items are expensive and unnecessary and will, if anything, make private flying less accessible to the average man due to high cost The whole concept makes as little sense as a government program of research for the purpose of telling Detroit how to build automobiles, a point which, fortunately we have not yet reached

The light aircraft business is very competitive and the industry itself is certainly more interested than any other party in broadening its market through better cheaper and easier-to-handle products

If the FAA is fortunate enough to have funds available for the furtherance of general aviation may I suggest that some of that money be spent for instance retaining and operating many of the low frequency communications stations that are gradually disappearing These are a major safety feature particularly in the Northwest with its difficult terrain

Meanwhile, it seems that Project Little Guy is a misnomer, it should rather be Project Big and Wealthy Guy, and he seems to be heading for the last thing general aviation needs—positive control

L G Romberg
Seattle, Wash

Air Travel Comments

Subject Why Don't People Fly the Airlines?

Last week I had the privilege of traveling from Los Angeles to Carbondale, Ill to watch my father receive a special award

Three comments

1 It was cheaper and faster to rent a plane at St Louis than to fly to Carbondale and back than to use a rental car (And of course essentially impossible to use the airline because of infrequent service)

2 My father a retired college vice president came by train from Portland, Ore He likes to fly (returned to St Louis with me by Tripacer) but the nearly $300 air fare is significantly larger to him than the $100 train fare My brother an associate professor with three college students drove through in 35 hr from Arizona Their reason for not taking the bus was money Being a rich engineer, of course I flew

3 Since it was on me instead of the company, I appreciated (negatively) the fact that I used to cross the country all the way for about the same amount I appreciated (positively) the "confused" fare structure which for some reason gave me a $16 refund for flying "Night Coach"

Robert C Howard
Los Angeles, Calif

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